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1953

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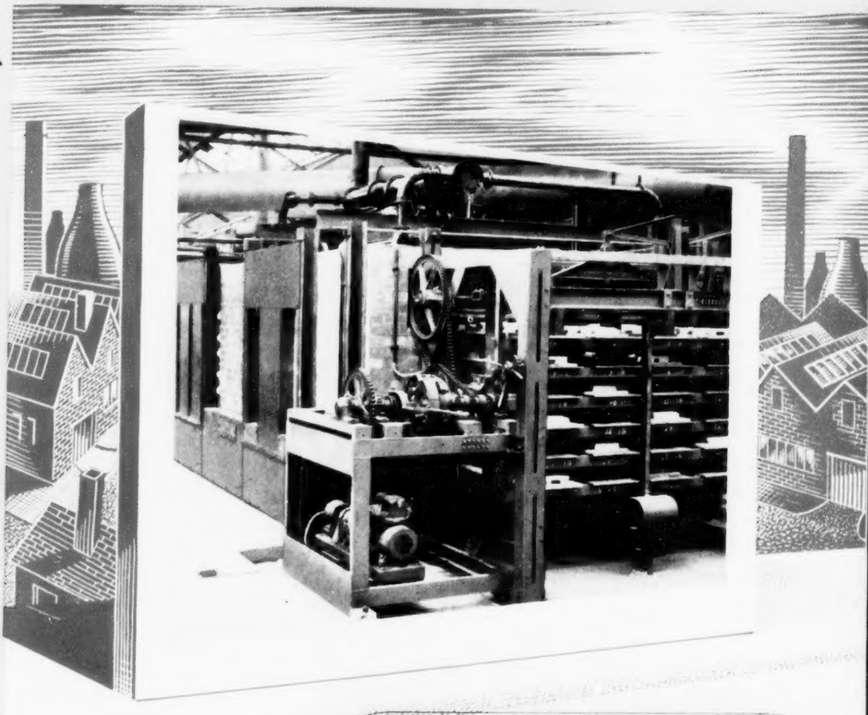

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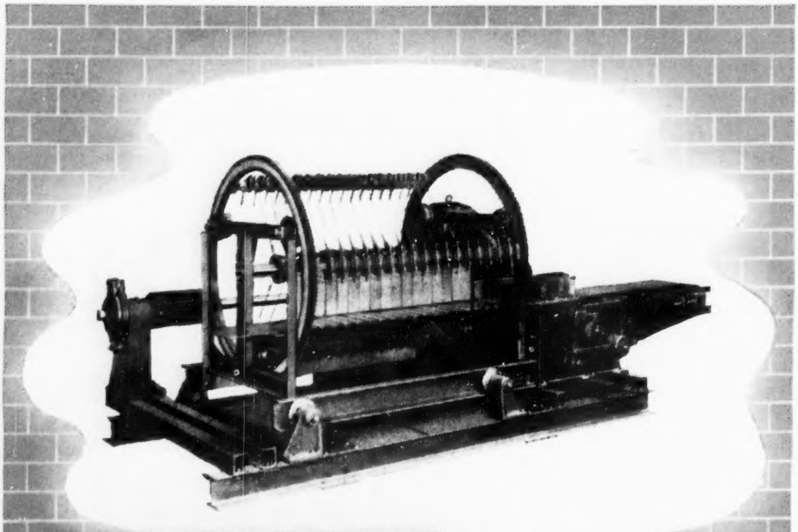

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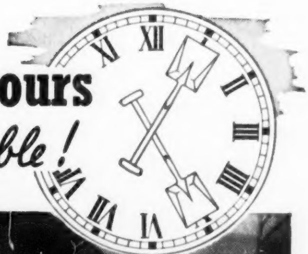

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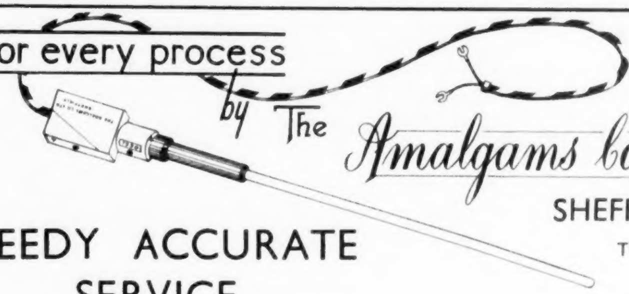

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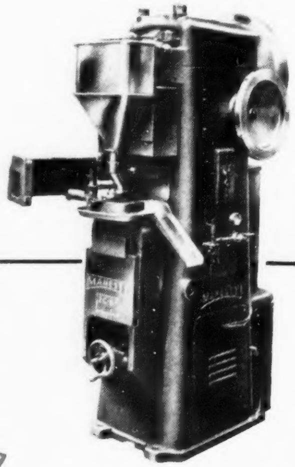

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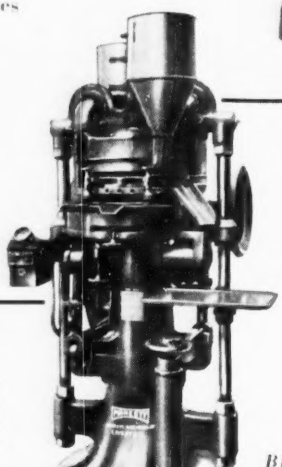

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Ceramics

VOL. V DECEMBER, 1953 NO. 58

Lower Gas Prices?

IN the pages of CERAMICS we have continually stressed how much the manufacturing costs of ceramic materials are influenced by fuel costs. How there has been a gradual increase in the price of both electricity and gas. Kilns have been installed at great capital cost in the expectation that they would pay for their capital cost in a given period of years, when in effect increased fuel prices have increased this period unduly. The British Pottery Manufacturers' Federation and the North Staffordshire Chambers of Commerce have fought a losing battle with the West Midlands Gas Board, through the Consultative Council machinery.

However, in the neighbouring Gas Board, the East Midlands, some positive action has been taken to reverse the trend of increasing gas prices. Recently the Chairman of the East Midlands, Mr. Sydney Smith, announced that a revision of gas tariffs would lead to reduced prices to a high proportion of the domestic and industrial users throughout the area—it will cost his Board £160,000 per annum against their net operating surplus of only £279,000 last year.

He said:

"On the industrial side, consumers whose business was especially valuable by reason of their load factors, and who were at present given no price advantage, were firms operating continuous processes for a 24-hour, seven-day working week. These firms were highly economic to supply, requiring no additional gasholder capacity and not aggravating the peak load."

There is no doubt that the gas industry is extremely worried about the cost of its fuel, and the East Midlands Board having taken the initiative one can expect the other boards to follow in its wake.

Any trend, small as it might be, to reverse these continually increasing fuel prices cannot help but be welcomed by all industrial users and the pottery industry in particular.

Waste Heat Utilisation

(SPECIALLY CONTRIBUTED)

THE present price of coal and other forms of fuel and power has given an added impetus to savings of all kinds.

In many processes in the ceramic industries, the cheapness of fuel and labour led to practices which have been continued down to the present time. The sharp rise in the price of fuel in post-war years has been shown in a recent article in CERAMICS (W. L. German "Trends in Firing in the Ceramic Industries," CERAMICS, November 1953), and this means that steps must be taken to conserve fuel in all possible ways, either by the introduction of new methods of firing or, where this is not possible, by adopting methods for collecting and utilising heat which is normally wasted.

Magnitude of Potential Heat Recovery

The magnitude of the heat wastage in some types of kilns is shown by the following results:

Heat Balance for a rectangular kiln firing bricks (Brit. Clayworker, **17,** 1945).

Details of Kiln

Length 30 ft.
Width: 10 ft. inside bag walls or 12 ft. 6 in. outside bag walls.
Height: 6 ft. to spring of arch.
Capacity: 24,000 bricks.
Fired to 1,200° C. in 9½ days.
Moisture in bricks as set: 6 per cent.

Heat Balance

	of heat available in coal
To heat ware	17
Heat stored in walls, etc. ...	20
Heat to evaporate moisture ...	2
Heat loss through walls, floor, etc.	20
Flue gas loss	41

For an intermittent pottery kiln the figures may be as follows: (E. Rosenthal, "Pottery and Ceramics," 1949).

Heating ware saggars and supports	10-12
Heat taken up by kiln structure	30-40
Heat lost by radiation and conduction	20-30
Heat lost in waste gases	20-30

See also (E. Rowden, *Trans. Brit. Ceram Soc.*, **52,** 436, 1953) who gives the following results for kilns firing roofing tiles:

Kiln	1	2	3	4
Firing temperature °C.	1,150	1,125	1,020	900
Duration of fire (hours)	610	216	177	81
Per cent. heat in fired goods and setting at end of fire	17·1	11·3	17·1	20·6
Per cent. heat stored in kiln at end of firing	9·6	14·2	21·6	18·7
Per cent. unaccounted for (heat in foundations, etc.)	5·2	22·3	7·2	15·0
Per cent lost by radiation and convection from kiln surface	9·9	6·8	7·3	4·9
Per cent. lost in stack gases	51·9	41·6	40·9	36·5

The same author gives the following figures for intermittent kilns firing salt glazed pipes and silica bricks:

	Salt glazed pipes	*Silica bricks*
Heat stored in ware at finishing temperature	10	13·5
Heat lost in flue gases	43	44·5
Heat stored in kiln structure and losses by conduction, convection and radiation (by difference)	43	36·0

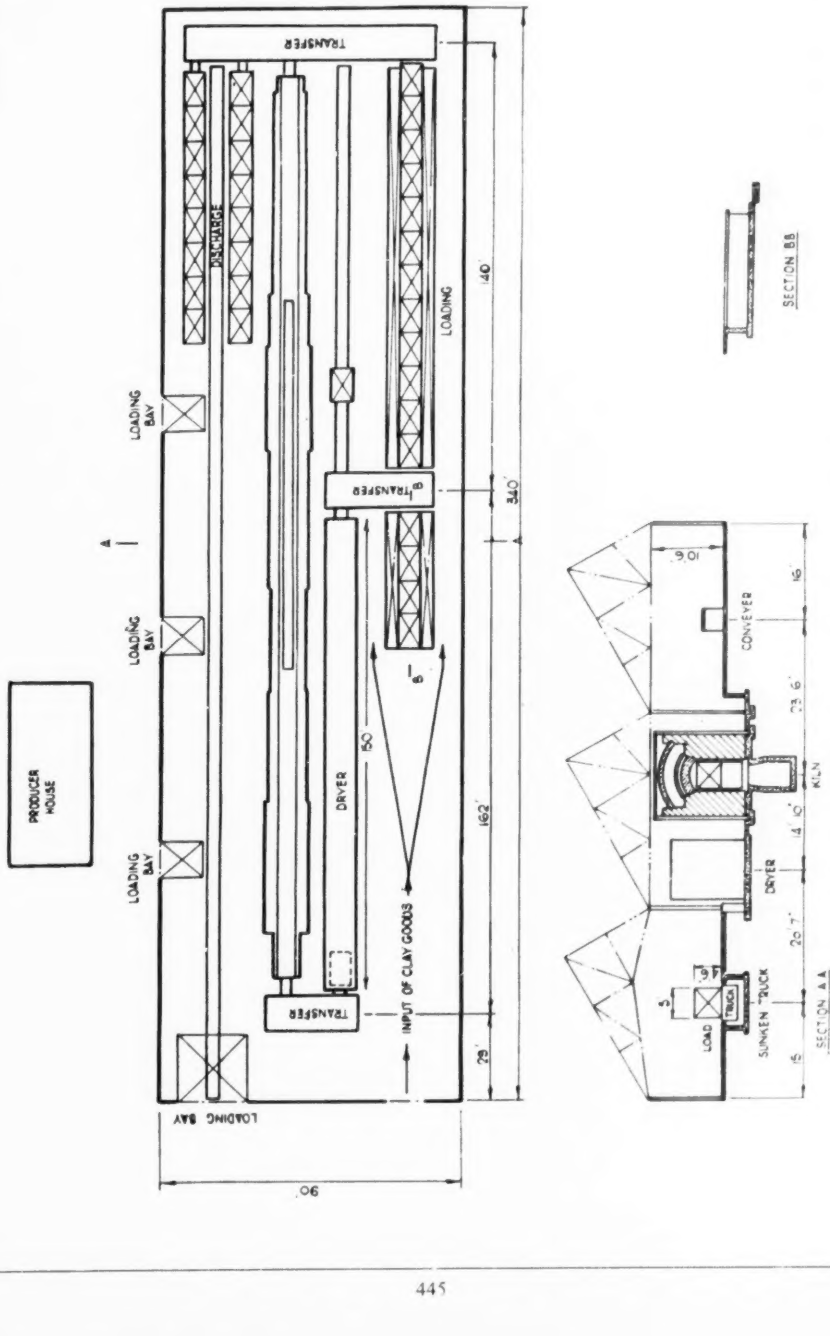


Fig. 1. Kiln showing a dryer built alongside operated by waste heat

There is considerable variation in the values under the various headings depending on firing temperature and how well the kiln is insulated, etc.

What is apparent, however, is that intermittent firing is wasteful, and that it offers possibilities of recovering heat which was formerly wasted when the cost of recovery was too high compared with initial fuel costs. Now that coal has risen from a pre-war cost of around 14s. a ton to its present price of 65s., waste heat recovery becomes increasingly profitable.

Ways of Recovery

Two profitable sources of heat recovery are the waste gases that go to the stack, and the heat in the ware and kiln furniture when firing has ceased. Losses from the kiln itself by conduction, convection, and radiation are best dealt with by suitable insulation, which is rendered easier by the modern hot face types now available.

Figures available, indicate that the heat stored in the ware and in the kiln and kiln furniture may in some cases total up to about 40 per cent. of the total heat input, and much of this should be recoverable by suitable methods.

Heat lost in the stack gases in intermittent kilns may run up to 40 per cent—the aim is, therefore to recover some of this, too.

We may consider the ways of recovery under two headings:

(a) by modern kilns such as tunnel ovens and continuous brick kilns in which the heat in the ware and kiln furniture is recovered, and in which the products of combustion are made to heat the primary and secondary air for combustion.

(b) by adaption of intermittent kilns so that the heat in cooling ware and kilns is made to heat air which is then used for drying and preheating ware, or by inter connection to operate a number in a similar manner to a continuous kiln.

Utilisation of Heat in Electric Kilns

Tunnel kilns can be divided for convenience into three zones—preheating, firing, and cooling. In most kilns these zones are of approximately equal length. Heat recuperation systems vary in different types of kilns.

In electrically-fired kilns where no large volumes of heated gases have to be handled the recovery of waste heat is relatively simple. The means adopted usually involves having two or more tunnels which are separated by thin party walls (in some cases the wall is omitted). In these the ware moves in opposite directions so that hot ware moving in one direction meets unfired material coming in the opposite direction and becomes heated by radiation from the other.

The effectiveness of this is such, that in the multi-passage kiln in which sixteen, twenty-four or thirty-two small passages are built up into a unit and the ware moves through them in opposite directions, very high heat efficiencies are obtained as shown in Table I. The recuperation is so good that it is possible to use electric power for firing, and yet fire as cheaply as when other fuels are used in older types of tunnel kiln.

It is significant that gas engineers are experimenting with methods of making a similar type of kiln fired by gas. It is claimed that these are now in an advanced state.

Gas-fired Kilns

In gas-fired kilns the problem involves moving masses of heated air. How this is done depends on the type of kiln.

TABLE I.

Results of firing earthenware glost in an electrically-fired kiln having four small passages moving in counterflow.

Length of kiln: 28 ft. 6 in.
Height of passage: 6 in.
Width of passage: 10 in.
Period of test (hours): 14.
Power consumed: 277 KWH.
Cycle (hours): 14.
Maximum temperature: 1,050° C.
Weight, cranks (lb.): 423.
Weight, bats (lb.): 909.
Weight, ware (lb.): 491.
Moisture on ware: 1 per cent.
Ratio ware/furniture + bats: 1/1·96.
*Over-all thermal efficiency: 96 per cent.

** Calculated by dividing the calculated heat required to fire ware, props, bats, etc., by the actual consumption. The high efficiency figure on this basis reflects the good heat recuperation achieved.*

The earliest types were muffle kilns, i.e., those in which the products of combustion are isolated from the heat-

ing chamber. In these the combustion takes place in the muffle and the products are drawn by a fan down to the entrance end of the kiln in flues along the sides of the kiln. Here they give up their heat to preheat incoming ware. The hot ware which passes to the cooling end gives up its heat to the kiln walls. These are cooled by currents of cold air drawn through flues in them and the hot air may be passed back into the kiln and again used for preheating ware.

There is usually more hot air available from a tunnel kiln than can be utilised for preheating and some of it is usually bled off to be used in driers and for factory heating (Fig. 1). In addition some of the hot air is usually used as heated primary air in the burners.

Recuperative Kilns

Recuperative types of kilns such as the Revergen employ regenerators built under the kiln to preheat the primary air for the burners. In such kilns the products of combustion are led down into a recuperator containing a honeycomb structure of firebricks (Fig. 2). When this becomes hot enough the firing is switched over, so that the products of combustion are passed to a second recuperator on the other side of the kiln, which in turn becomes heated. Meanwhile the first is cooled by having air drawn through it, which is then passed to the burners.

In such kilns it is usual to fire the burners on each side of the kiln alternatively, and the change-over is made about every 20 min., the operator being warned by a bell.

The method of cooling the ware is similar to that already described.

The hot air obtained is sometimes superheated by passing it through a duct built into the top of the kiln over the firing zone. This air is then used for preheating ware and also for heated primary air. The fuel savings effected by the use of recuperators on

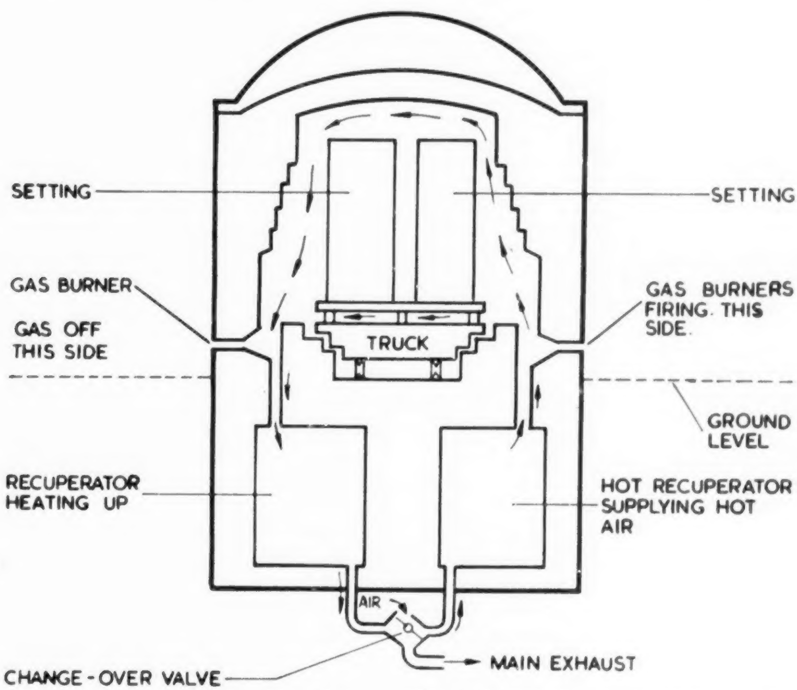


Fig. 2. Diagrammatic drawing of recuperative kiln, showing regenerators underground

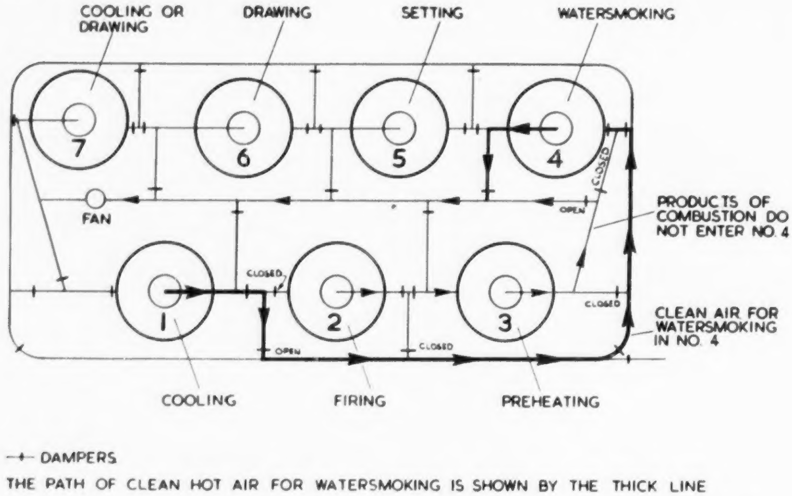


Fig. 3. Minter system of inter-connected round intermittent kilns. (*After E. Rowden*)

kilns are often not appreciated. Where recuperators are constructed of metal and placed over the kilns efficient lagging greatly improves fuel efficiency as evidenced by falling gas consumption.

Continuous Brick Kilns

For continuous brick kilns of the ring and multi-chamber type very effective use is made of the products of combustion and the sensible heat in the fired product and kiln. The principles involved are not new, but with higher fuel costs more attention is now paid to efficient operation.

In brief, the products of combustion in the chamber on fire are led into the ovens in front where they preheat bricks already dried and raise them to red heat ready for firing, and pass on to dry out green bricks in other chambers. Finally, the cool, moist air is drawn off to the chimney stack. Bricks that have been fired are cooled by cold air drawn in from outside through chambers being unloaded and this hot air forms the preheated air for combustion in that chamber being fired by dropping coal through holes in the roof.

In modern kilns and under conditions where use of the products of combustion cause scumming, because of sulphur gases present, the drying is sometimes done by using some of the preheated air from the cooling bricks. This is done by drawing clean air through the fired bricks and passing it in a flue direct to the chambers containing the green bricks.

Methods of utilising waste heat in the heavy clay industries have been reviewed by E. Rowden (*Trans. Brit. Ceram. Soc.*, **52,** 69, 436, 1953). These comprehensive articles are devoted to considerations of heat recovery in steam plant used for heating dryers, and heat recovery in works with intermittent and continuous kilns both at home and abroad. It is with intermittent kilns that the remainder of this article is mainly concerned.

Possibilities of Heat Recovery in Intermittent Kilns

Heat balances have been given for intermittent kilns firing tiles, silica bricks, and salt-glazed pipes (see previous sections). These emphasise the point already made that heat in the flue gases and in the ware and kiln structure offer possibilities of large recoveries of heat.

Heat recovery from the flue gases may be effected by connecting up several intermittent kilns so that the hot combustion products can dry and preheat freshly-set ware as in the continuous kiln. For this to be profitable

the kilns need to be grouped reasonably near each other otherwise the cost of ducting may be prohibitive, and the heat losses *en route* too great. This may make the scheme impracticable on some older works.

The Minter System

This is described in an article in *Brick and Clay Record*, **61**, 102, 1922. It involves connecting a series of round intermittent down-draught kilns with a flue system, dampers and a fan so that the following operations can be carried out:

(a) hot air from a cooling kiln can be passed into a kiln which is preheating or water smoking.
(b) hot combustion gases from a kiln being fired can be passed into another kiln for preheating.
(c) waste gases which have become cool and moist can be discharged to air.

The kilns can then be operated like a continuous brick kiln.

For a battery of seven kilns a fan of about 25 h.p. is required. The general arrangement is shown in Fig. 3 which is self-explanatory. The water smoking in Kiln 4 is done with clean hot gas from Kiln 1 which is cooling. Preheating Kiln 3 is done by hot gases from No. 2. These gases do not reach Kiln 4 and are subsequently passed out to atmosphere by the fan.

Rowden describes a similar system for interconnecting rectangular kilns. He gives the following figures for fuel saving by using waste heat:

Hot Air from Cooling Kilns

Hot air extraction from cooling intermittent kilns has achieved some popularity where it can be adopted.

A ducting and fan are installed so that air can be drawn off from the cooling kiln and passed to the drying sheds. There air is taken off at a series of openings on the lower sides of the ducts. The system is controlled by dampers. Care is taken to prevent direct impingement of hot air on the green ware because of the danger of cracking. As in other systems of heat recovery the drying sheds should be near the kilns so as to reduce the cost of ducting and the possibility of heat losses.

As an alternative to passing the hot air into the drying shed it may be sent to a tunnel dryer. This is a more efficient method of utilising it. Rowden points out that care must be exercised in taking off hot air from cooling kilns. As is well known, sudden cooling can cause dunting, and some clays are more susceptible to this than others. The time which must elapse between finishing firing and taking off hot air must be determined by experience. In some cases a few hours is sufficient, in others the time is much longer. Roofing tiles may require cooling to about 500° C. before hot air can be drawn off successfully and this may take 2-3 days. It is recommended that the temperature of the air should not exceed 120-140° F., and that it should not impinge directly on the ware. This is to prevent cracking due to too rapid drying.

TABLE 2.

	Coal consumption (cwts/1,000 bricks)		*Saving cwt./1,000 bricks*
	Interconnected kilns	*Normal intermittent kilns*	
Five interconnected rectangular kilns (fan draught)	15	20	5
Five-chamber semi-continuous kiln (high stack)	14-15	20-21	6

Flues should be of minimum length and should not be damp. Draught must be good, either by means of a fan or by a stack 120-50 ft. high.

Practical Details

The cost of installing the equipment to deal with waste heat from intermittent kilns in this way is not small.

Sheet metal ducting of 1 ft. 6 in. to 2 ft. 6 in. dia. is used. This may cost over £1,000 per kiln, and the power costs for the fan may be about 1s. an hour. If too much heat is not to be lost the parts of the duct out in the open air should be insulated. This adds to the expense.

Cases have been noted where the ducting adjacent to the kiln rapidly corrodes away due to excessive heating. A method of preventing this is to operate a damper, so that the temperature of the air is reduced by diluting with air taken in from outside. Alternately the hot portions of the duct are constructed in brick work.

In the U.S.A. the ducts are put underground and constructed in brick and the air is drawn down through the kiln. Brick resists the heat and possible presence of acid fumes.

Application to Kilns Firing Roofing Tiles

Rowden describes an example of rectangular down-draught kilns firing roofing tiles in which metal ducting is used to extract waste heat and pass it to the dryer. These hold 55,000-83,000 tiles each. Heat is taken off at three places on the crown of each kiln and the temperature is regulated to prevent overheating of the ducting by adjusting a visor over the hole in the crown so that a certain amount of fresh air passes in to mix with the hot air. The various ducts pass to a manifold and are insulated. Provision is made for supplying extra heat when required by connecting the system to a tubular air heater fired with coal.

After drying the tiles are fired and the kiln is then kept sealed up for four days. Thereafter, air is drawn off. The setting was then at 540° C. and the air immediately in front of the fan at 313° F. After taking off air for 51 hours the top of one wicket was broken open and the off-take nearest it closed. Tiles were drawn from this end 16 hours later. After 24 hours the central off-take was closed and more air drawn. After 102 hours the air temperature had dropped to 126° F. and after 122 hours, 100° F. At this stage it was still used mixed with hot air from other kilns. After 142 hours air withdrawal was stopped.

Calculation showed that in this way 40 per cent. of the total heat in the setting and kiln structure above ground at the end of firing was recovered, or 15½ per cent. of the total heat input to the kiln. The air heater was not used in the summer and over the year an average of 0·59 cwt. of coal was used per ton of fired goods. The coal fired in the kiln averaged 4·9 cwt. per ton of fired tiles. This was a production of 105 tons or 95,000 tiles.

Heat Recovery on Boiler Plant

Nothing has been said of the use of heat exchangers in recovering some of the heat in the flue gases of boiler installations. This is a practice widely adopted in many industries, including ceramics, for preheating the boiler feed water and it makes a valuable contribution to recovering some of the heat which normally escapes up the chimneys (cf. E. Griffith, *Trans. Brit. Ceram. Soc.*, **51**, 409, 1952).

DOLOMITE FROM NORTH ARGYLE

The first major consignment of dolomite from North Argyll has been dispatched, bringing to fruition, plans for the exploitation of the dolomite resources of this area. About 80 tons of rock left the Duror area at the end of November for processing and a steady expansion of the industry is expected to mature.

The mineral development of the Scottish Highlands has been advocated for many years, by people who visualised native resources as being capable of maintaining local industrial points. In far too many cases the resources are too isolated or too sparse to justify the large-scale operation, but in this case, the volume of available supplies and the potential outlets are such to ensure that this material at least, can be fully exploited. First returns will be in terms of wages to the local quarrymen, and an increased labour force will be available when the industry develops. Other advantages will be to local labour in terms of improved roads wages to transport workers, and provision of improved housing and amenities while at the manufacturing end, the advantages of a steady flow of materials, from native sources will allow further development.

Earlier this year, details were announced of large scale industrial projects in Stirling and Glasgow in which Argyll dolomite will play an important part.

THE BRITISH POTTERY MANAGERS' & OFFICIALS' ASSOCIATION

Five Short Talks

AT a recent meeting of the Association, at which all branches were represented, and with Mr. G. Mountford in the chair, a series of five short talks were given by branch members.

Mr. J. Williams of the Tunstall and Burslem branch opened with a talk entitled "Past, Present and Future." He said that there was a changed outlook in the industry and a new attitude and outlook of pottery managers, who should review the past and glean from it that which was best, consider the present, and plan for the future. In the past, most potteries were run by the actual owner or owners, and to facilitate day-to-day supervision in the various departments, they promoted the more experienced and conscientious workers to be departmental foreman. This worked very well in the days when practical potting was more to the fore than scientific application, and when disputes arising out of conditions, prices, etc., arose, these were dealt with by the owner. In other words the owner was his own works manager.

With the advent of mechanisation and more scientific knowledge, some of the responsibility for under-management had to be delegated to managers, who in addition to practical knowledge, then required theoretical knowledge and an altogether wider outlook. It would appear, therefore, that we now have a reverse process, in managers starting with theoretical knowledge and gaining practical knowledge as they go along.

Looking to the future Mr. Williams said that one obvious trend was the combining of a number of factories into a group which was centrally controlled, and the question was arising: "Will this make any difference to the pottery manager?" In his opinion it would. It will make for more efficient and specialised departmental managers who will not only be quality conscious but also cost conscious, and that there will emerge more clear-cut definitions as to the duties of particular managers together with an increase of such men as progress managers, production managers, technical managers, etc. He felt that the Pottery Managers' Association had realised this and was catering for every aspect of management within the industry and it was up to every member to see that he personally was an efficient and conscientious manager, for upon their combined efforts the future of the running of the industry depended.

Mechanisation

Mr. H. Degg of the Longton and Fenton branch spoke about mechanisation in the china industry. He said that during the past few years there has been a great increase in the automatic making of earthenware, but with one or two exceptions the actual making of china has not been mechanised.

There have been many changes and improvements but largely in the ancillary parts rather than in the actual making, e.g., improved drying facilities, better layout to facilitate handling and more extensive use of continuous firing. One of the reasons for this is that the body is not normally plastic enough, and he felt that there was scope for investigation into a suitable plasticiser for use at least in medium-grade china bodies. Generally speaking, china firms are smaller units than earthenware and consequently have neither room or capital to warrant laying out for fully automatic making, coupled with the fact that the composition of orders was of great variety as to shapes and patterns rather than bulk orders, and the large quantities of one shape necessary to make mechanisation practicable are not generally available.

In the making of cups, a single cup jolley and a few semi-automatic machines are the nearest approach to automatic making, and Mr. Degg said that he suspected that the reason for this was the fact that throwing seems to be a dying trade, although in his opinion a well-thrown cup is superior to a jollied one, particularly with a footed cup, and such cups are always in popular demand. The automatic turning of cups seems to be a proved and established form of mechanisation within the china trade, but once the problem of a plastic body has been overcome, mechanisation in general would be bound to increase.

De-airing of Plasters

Mr. A. Clough of the Longton and Fenton branch followed up a talk given

by him to the Association some time ago with further thoughts on the de-airing of plaster.

He said that after recent trouble with moulds he had investigated the plaster question rather thoroughly, particularly from the angle of coarseness. The plaster he had been using gave 78 per cent. through a 200 lawn, but a plaster giving only 60 per cent. through a 200 lawn showed a definite improvement in the moulds. The coarser plaster was not available in the delayed setting form, and his experience had shown that for the de-airing or vacuum blending process, delayed plaster was essential. Using the coarser plaster and hand blending, 300 fillings were obtained as against 165 fillings with the finer plaster hand blended. One point established was that is was possible to increase the amount of plaster to water using a coarser material, the plaster to water ratio being increased by 20 per cent. and the water absorption figures being altered from about 32 per cent. to an average of 29 per cent. He thought that this was one reason why an increased life of mould was obtained and he expected that with the delayed setting form of this plaster an even greater increase would be obtained when future blending was used.

Slip House Practice

Mr. S. Bloor of the Stoke and Hanley branch spoke on certain aspects of slip house practice. He gave details of experiments carried out on the question of press cloths. He said that cotton inside cloths with jute back cloths gave an average life of 120 fillings. Using nylon cloth the life was increased to round about 500 fillings, but by using jute back cloth to nylon the jute deteriorated very quickly, probably due to the fact that bacteria from the slip had no effect on the nylon and, therefore, concentrated on the jute.

It was found that it was an economical proposition to use 7-oz. or 7½-oz. nylon cloth instead of the lighter weights and that metal scrapers should never be used. He recommended perspex scrapers as a good substitute and said that they treated the cloth more gently. It was a good plan to wash each cloth daily with warm water, for a clean press was an economical one. It is not necessary to repair cloths for small holes or faults, but if the cloth was allowed to dry completely and each fault covered on both sides of the cloth with Durafix, which should then be allowed to dry, the cloth would then be good for many more fillings.

He said that he had experience of nylon press cloths which had done well over 2,000 fillings.

He told of a series of experiments conducted on clay from the press and from the pugs, when moisture contents and photographs of cross sections of cakes were taken, and the softer cakes separated from the hard ones. It was amazing how consistently the same trays gave the same results, but each tray often differed from the next. This was cured to a great degree by manipulation of back cloths. Where the cakes were soft an open weave PVC back cloth was used thus allowing quicker local filtration and he stated that in his opinion jute back cloths not only had a short life but were also one of the causes of the variation in the cakes of clay they produced. By use of the photographer and freezing slabs of clay cut from the wad as it came out of the pug mill, it became obvious that all the pugs in use did not produce a consistent result.

Mr. Bloor passed round photographs of the frozen clay showing the varying degrees of rupture caused by the frozen water, and after saying that a right-angled bend added to the outlet side of the pug gave sufficient back pressure to consolidate the clay more, he showed photographs of similar wads after the bend was added which showed a greatly reduced degree of rupture after freezing.

Export Markets

A short résumé on conditions prevailing in some of the export markets was given by **Mr. Timmins**, who made particular reference to the importance of the United States and Canadian markets to the pottery industry.

Attention was also drawn to the value of the American tourist areas, such as the Bermudas, the Bahamas and some of the Caribbean areas, where Americans on holiday could take advantage of the sale of bone china and could bring back to the United States up to £500 worth of china free of duty.

It was considered that a more encouraging position could be obtained in Australia and New Zealand, where Australia had considerably modified the restrictions that were put into operation some time ago.

The position in New Zealand also appeared to be improving, and there seemed to be a chance that a greater volume of exports to that country should remain in 1954 than in 1953.

The position in Europe was also outlined, where it was noted that Italy had a fairly free importing system.

The position in France at the moment was hopeless, due to the balance of payments position. Imports could be made into Federal Germany under licence, and to Spain if licences could be obtained.

The Middle East was also mentioned, where it appeared that restrictions imposed by Pakistan and India made trade with those countries difficult.

(Continued from "Ceramics," November, 1953)

The Drying of Tableware and Other Ceramic Goods

By the Jet Drying Method

by W. HANCOCK, M.I.B.R.E., A.M.I.E.E.

2.—THE JET DRYING OF CUPS

CUPS must be dried to a moisture content which enables the fixing of cup handles to be most efficiently achieved. In this respect, the drying of cups differs from that of flat-ware, which can hardly be over-dried.

To obtain cups in the correct condition for handling, approximately one half of the initial water content (30 per cent. calculated on dry clay weight) must be removed. Excessive drying of cups inevitably means poor adhesion of handles and high loss—while insufficient drying will cause distortion of the cups as they are removed from the moulds, during sponging, or when they are being held during fixing of the handles. Uneven drying, particularly with wet moulds, causes "crooked" ware.

Fortunately, the actual moisture content of the cup in the optimum condition for the application of the handle is not over-critical with most tableware bodies, and may usually vary by ±2½ per cent. around an average of about 14 per cent.

Cup Jet Dryer for Moderate Production Rates

One of the earliest forms of cup jet dryer is shown in Fig. 2. This small circular unit carried 120 moulds in its twelve sectors, giving ten cups per sector. With a diameter of 5½ ft. and height of 7 ft., it was one of the smallest units made, and its construction was characterised by simplicity, high thermal efficiency and low cost. The bottom of the shelves above each cup had a jet orifice of ½ in. dia., approximately 1 in. above the top of the cup mould.

Other relevant data for this dryer is given below:

Rated volume output of fan: 3,900 c. ft./min. Actual air delivered: 2,400 c ft./min. Air velocity at jet: 420 ft./min. Dry-bulb temperature: 105° F. Relative humidity: 15 per cent.

The fan is driven by a 3-phase motor, consuming 1·5 amps per phase at 416 volts, giving an approximate power cost of 1·50 KWH.

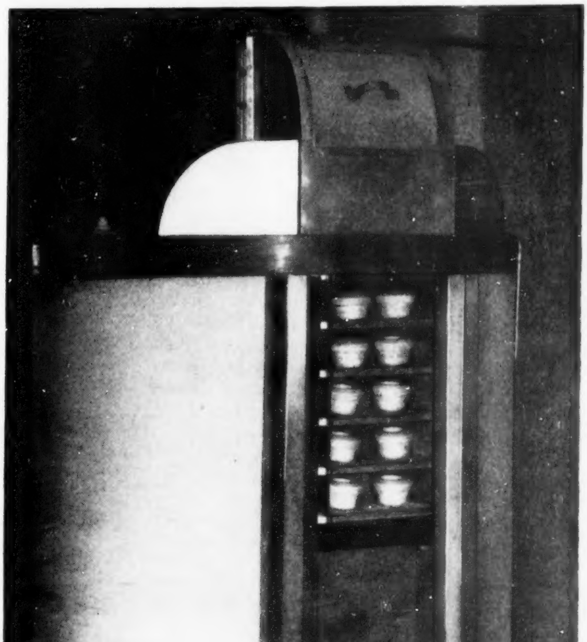
Steam and Power Costs

As will be shown, jet dryers with jets correctly positioned, and with high velocity of air flow through the jets are considerably more economical than the convection dryers previously in use. For example, with the single form of cup dryer described above, the steam and power consumptions relative to those required by a mangle dryer *working on the same ware*, were as shown in Table 1.

In both cases, drying took 30 min. during which 120 cups were dried in the jet machine and 180 in the mangle.

It will be seen that the mangle required over 150 per cent. more steam than the jet dryer, and almost 100 per cent. more power. However, one-third of the power used by the mangle was used for driving the machine, but nevertheless, the *total* thermal units (steam and electricity converted to heat units) used for drying were of the order of 150 per cent. greater with the mangle than with the jet dryer.

From the actual cost of drying view-



(Right) Fig. 2. An early form of cup Jet-dryer

(Below) Fig. 3. Rotary multi-jet-dryer for cups

(Photographs by courtesy: Victoria Heating and Ventilating Co. Ltd.)

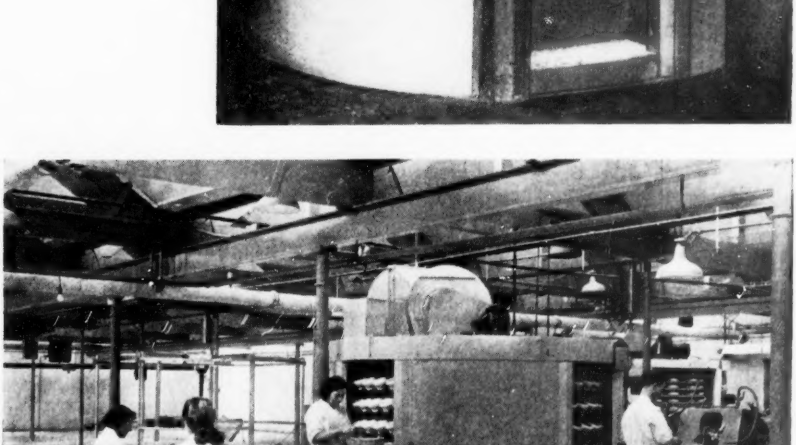


TABLE 1.

Pressure (lb./sq. in.)	Steam			Power		Total
	Consumption (lb./hour)	Per lb. Water evaporated	B.Th.U./lb. water evaporated	KWH	B.Th.U./lb. water evaporated	B.Th.U./lb. water evaporated
Jet 5/10	15	2·0	2,000	0·66	307	2,307
Mangle 5/10	60	2·0	5,400	1·94	591	5,991

point, with steam alone costing 6d. per therm (100,000 B.Th.U's) the evaporation of 100 lb. of water in the two systems would cost for steam:

Jet Dryer	*Mangle*
Steam cost 1s. (100 lb. water evaporation)	Steam cost 2s. 6d. approximately (100 lb. water evaporation)

The cups in question weighed 4·7 oz. plastic, 4·2 oz. as dried, and 3·6 oz. dry, i.e., each cup lost 0·5 oz. water in the dryers. Therefore, thirty cups lost 1 lb. and 3,000 cups lost 100 lb. water respectively. Thus, drying 3,000 cups in the jet dryer cost 1s. in steam as against 2s. 6d. in the mangle—a considerable economy in fuel cost for drying.

The economy in electrical units for the jet dryer as compared with the mangle, expressed as a ratio in B.Th.U's., is approximately the same as for steam per lb. of water evaporated. However, electricity per therm is approximately five times as costly as steam. Hence, the cost economy in electricity with the jet dryer is about 10d. per 100 lb. of water evaporated, giving a total fuel economy (steam and electricity) of 2s. 4d. for every 100 lb. water evaporated.

That is, for every 3,000 cups dried to handling consistency, the total fuel cost is 2s. 4d. less with the jet dryer. The weekly output from this earliest and simplest form of jet dryer was 440 dozen cups, i.e., 5,280 cups on the drying of which 4s. was saved, representing an annual economy of £10 in steam and electricity combined when compared with the mangle.

Relative Machine Costs

The respective capital outlays on the jet dryer and the mangle respectively were £240 and £650. Assuming that the capital cost would be written off at 20 per cent. per year, the jet cup dryer shows an economy, over 5 years, of £400 in initial outlay and £50 in steam and electricity, i.e., £450—a total of £90 per annum.

For a weekly production of 2,000 dozen cups, five dryers would be used, and the net yearly saving would amount to £450 for the drying of cups alone, using the early form of jet dryer.

The Labour Item in Drying Costs

The use of traditional stoves involved considerable addition to the cost of drying in the form of wages paid to mould runners.

One aim of modern drying methods has been to reduce the labour cost associated with the carrying of moulds to and from the dryer, and in the case of cup dryers to avoid the need for removing and replacing moulds in the dryer by making the removing of the cup possible without removing the actual mould.

In the earliest cup jet dryers, described above, it was necessary to remove the mould from the dryer before the cup could be extracted. With the latest development of cup jet dryers, however, this action is avoided, and the cups can be withdrawn from the moulds without removing the latter.

Cup Jet Dryers

One of the latest type cup jet dryers is shown at Fig. 3.

The diameter of this unit is 9 ft. 6 in. There are no hollow shelves in the dryer, and the air is carried to the jets from the central air reservoir through hollow rods projecting from the reservoir shell. These hollow rods leave the reservoir horizontally, but the outer end of each rod is inclined downwards at an angle of approximately 15°. The actual jets are on the underside of the inclined end, and directed vertically into the cups.

There are six rows of the projecting rods—or prongs—the upper five of which are air conductors to the jets. Sheet-metal pieces, cut out in semicircular form, are attached to the air conductor prongs, so that the cup moulds inclined slightly forward, are each supported under a jet unit.

As at present designed a jet prong may carry either four or five jets as desired. The four-jet type carries four circular jet orifices, each ¼ in. dia. spaced at ½ in. centres; while with the five-jet type the centre jet is ⅜ in. dia. with four smaller satellite jets of ¼ in. dia. Hence, according to shape and size of cups, the jet disposition is flexible in both trial and practice.

Data on the Modern Jet Cup Dryer

Dryers of the type shown in Fig. 3 have now been in factory use for about a year, and are giving every satisfaction. They are 9½ ft. in dia., as against 5½ ft. for the prototype, and carry 240 moulds as against 120. The linear velocity of the air at the jets is 2,000 ft. min. The dryers are being fed from a double-headed semi-automatic jigger, with a production of 12 cups per min.—i.e., three times the original production rate.

As will be seen from the photograph, the loading and unloading stations are now separate. It will be noticed that the unloading position is approximately 90° from the loading station. This allows any residual moisture in the moulds to be evaporated before the moulds are re-filled. Moisture content of the mould is thus maintained relatively constant.

With this form of dryer—drying six cups per min. in 28 min.—shop air used at 2,000 ft./min., linear velocity at the jets dried the cups satisfactorily, *without the use of steam.*

Since the fan motor uses 2 amps per phase, the power consumption is 0·9 k.w./hour, or less than 500 B.Th.U. per lb. of water evaporated. Drying twelve cups per min. in 14 min. is achieved at relative low dry-bulb temperatures (100-110° F.) and with a correspondingly low steam consumption. The actual fan output was checked as being 2,600 c. ft./min.

The output of the latest dryers is, therefore, three times that obtained from the smaller type dryer, but the cost of the units is only approximately twice that of the prototype.

POTTERY EXPORTS

THE value of pottery exports in October was £2,069,525, compared with £1,943,972 in the same month last year, and compared with £2,582,576 in October, 1951.

For the first 10 months of this year the value of pottery exports was £17,576,683, compared with £22,288,280 in the first ten months of last year, and £22,444,839 in the corresponding period of 1951.

The volume of pottery shipments in October was 458,082 cwt., compared with 475,661 cwt. in October, 1952, and 620,923 cwt. in October, 1951.

In the first ten months of this year 4,223,475 cwt. of pottery was exported compared with 4,977,728 cwt. in the first ten months of last year, and 5,288,142 cwt. in the first ten months of 1951.

(Evening Sentinel.)

Considerations in the Design of Gas Combustion Systems on Tunnel Kilns Affecting Fuel Economy

by R. G. LEGRIP
B.Sc., A.M.Inst.Mech.E., M.Inst.F.
(Messrs. Gibbons Bros. Ltd.)

FOR all thermal processes involving heat transfer and particularly those dependent on recuperation, before it becomes possible to investigate combustion efficiency, an ideal working cycle must first be established. Results attained in industrial practice can then be measured against the ideal standard, and an assessment made of how far we have approached the ideal. As we shall see, the successful operation of an open flame kiln is largely dependent on the proper application of the recuperative principle and it is proposed to concentrate on this application in this lecture.

A talk given to The British Pottery Managers and Officials' Association, during October 1953.

The Ideal Cycle (Fig. 1)

The ideal kiln is a tunnel supplied with cold air at the cooling end either by forced means or by induction, and with exhaust arrangements at the entrance end. There are no radiation losses and no leakages.

Ware entering and passing along the preheating tunnel is gradually heated up to the final working temperature by the hot air from the cooling goods. The only addition of external heat is that to

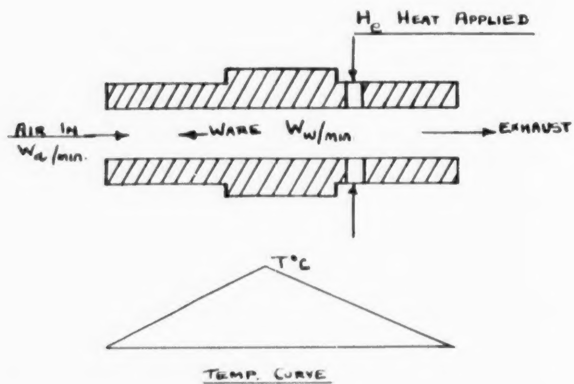


Fig. 1

HEAT TO AIR FROM COOLING WARE (+ H_e) = HEAT IN WARE AT T°C

OR $S_a W_a T \ (+ H_e) = S_w W_w T$

FOR INERT WARE $H_e = 0$. ALSO $S_a = S_w$

HENCE $W_a = W_w$.

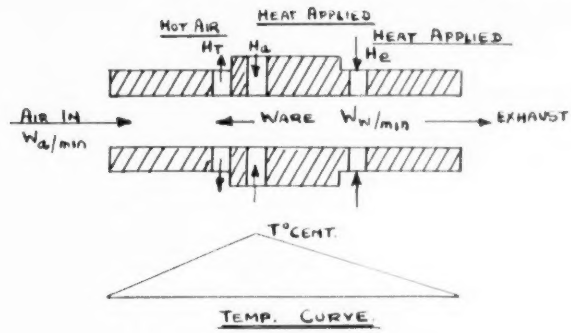


Fig. 2

$$\text{HEAT TO AIR FROM COOLING WARE} - H_T + H_a (+ H_e) = \text{HEAT IN WARE AT } T^\circ C$$

$$\text{OR } S_a W_a T - H_T + H_a + (H_e) = S_w W_w T$$

$$\text{IF ALL AVAILABLE HEAT IS DRAWN OFF } S_a W_a T = H_T$$

$$\text{AND } H_a + (H_e) = S_w W_w T$$

cover the irrevocable losses, i.e. the heat required to cover the difference between the endothermic and exothermic reactions. In the ideal kiln, this heat is applied at the point where the reactions take place, and exhausted at the main exhaust. It is to be noted that a charge of heat is initially required to set the cycle in action; once the cycle is established no further heat except the irrevocable heat is required and the cycle continues automatically.

Study of Fig. 1 reveals the interesting fact that since no combustible enters the peak temperature zone, the atmosphere in the main zone will consist of oxygen and nitrogen with no carbon dioxide, from which we can infer that subject to certain reservations the less the CO_2 content in the main zone of a tunnel kiln of the open flame type, the nearer the cycle approaches the ideal cycle, and hence the closer does the kiln performance approach the maximum theoretical combustion efficiency. I stress combustion efficiency as against overall efficiency.

The above relationship constitutes one of the big fundamental differences between a tunnel kiln and a furnace or boiler. In furnace work the aim is to approach as nearly as possible to the theoretical CO_2 content, due consideration being given to the effect of preheated combustion air. In tunnel kilns the exact opposite holds, but it is a regrettable fact that this does not seem to be generally appreciated. We shall return to this point later after further consideration of the ideal cycle.

The Ideal Cycle (Fig. 2)

This diagram represents the same unit as in Fig. 1, but in this case a certain amount of hot air is withdrawn from the cooling zone at a point near the peak temperature in order to supply some industrial application in the factory.

We deal first with withdrawal of the entire amount of hot air available from the cooling goods.

It is obvious that the lost heat must be replaced by an exactly equal amount of heat put into the peak temperature zone. Since no hot air is available for combustion, cold atmospheric air must be used in the proportion of four or five volumes of air to one of town gas. Also the weight of air and gas put in must equal the weight of hot air drawn off. The atmosphere in the peak temperature zone then becomes the theoretical combustion mixture with little or no excess air and a CO_2 content of round about 9 to 10 per cent. (wet). We have benefited by the production of a quantity of hot air H_T uncontaminated by products of combustion, but on the other hand the kiln atmosphere has become contaminated and no longer oxidising. The firing efficiency is also at its minimum level.

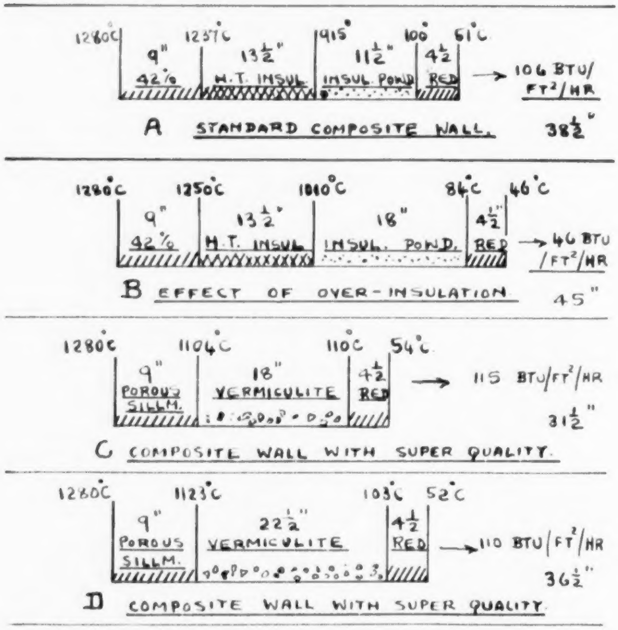


Fig. 3

We can of course render the atmosphere in the main zone more oxidising by admitting excess air with the fuel, but this air will be cold (or in practice not very hot) and extra fuel must be burnt to cope with this cold air. By no means is it then possible to obtain the kind of atmosphere obtainable with the use of the very hot air flowing from the cooling zone.

It will be shown later that practical considerations and economics force the withdrawal of some hot air from the cooling zone. In some cases a very large quantity of hot air must be tapped off to obtain proper cooling. But the fact remains that there is a definite limit to the amount which can be tapped off and that any attempt to exceed this limit leads to high fuel consumption, contamination of the main zone atmosphere, and other undesirable effects. This point will be made clearer later by practical illustrations.

We deal next with the withdrawal of half the amount of the available hot air from the cooling zone.

From Fig. 2 we see that the heat to be supplied to the main zone is equal to half the sensible heat in the ware at peak temperature, and of course equal to the hot air withdrawn. We already have half the combustion air in the form of hot air from the cooling zone at almost the full firing temperature. To this we must add an equal weight of cold atmospheric air and town gas, in the ratio of 4 or 5 volumes of air to one of gas, but now the gas required is only half that required in the previous case. We obtain an atmosphere produced from the combustion of gas and 100 per cent. excess air, giving a CO_2 content of round about 5 per cent. in the peak temperature zone of the kiln.

It will be seen that the atmosphere is more oxidising and the firing efficiency in the main zone twice that of the previous example. The overall efficiency of our ideal kiln still remains 100 per cent. because fuel input is balanced by the hot air output and hence there is no adverse balance of heat.

Conclusions from Figs. 1 & 2

We can now state quite logically that for an ideal kiln :—

1. The most efficient kiln uses in its peak zone all the hot air derived directly from the cooling goods.

2. The firing efficiency is reduced as the quantity of hot air drawn off is increased.
3. The CO_2 content in the peak temperature zone increases as the firing efficiency diminishes, and vice versa.

Since we are all interested exclusively in practical kilns, let us now proceed to examine how far the kilns we build can approach the ideal kiln, and to what extent the conclusions reached for the ideal kiln apply to kilns in practice.

It is certain that the ideal kiln cannot be built, and the various phenomena and disturbances which prevent us from reaching the ideal are generally as follows: —

(a) Radiation of heat from walls and roofs, also losses to foundations.
(b) Difficulties in transmitting heat from gases to solids, and in securing uniformity of heating.
(c) The buoyancy or convective effect which promotes a very powerful upward movement of the gases in the lower part of the load into the upper regions.
(d) Tendency to leakage into tunnel from under the trucks and at other points.
(e) The limitation imposed on the cooling rate by the difficulty of transmitting heat from solids to gases without producing excessive skin cooling.
(f) Momentum effects in gas streams causing loss of control of heating effects.
(g) Reverse movements of combustion gases into cooling zone.
(h) Difficulty of producing rapid combustion economically without generation of excessive heat and destructive flame effects.

The above are only some of the difficulties which befall the tunnel kiln designer. They are by no means in order of importance. Also the list could be considerably lengthened but the time at my disposal sets a limit.

Let us examine with reference to diagrams the precise effect of the phenomena listed.

(a) Radiation

Even with the use of the best insulation now at our disposal, properly matched to operate at the most efficient operating temperatures, we find ourselves unable to prevent a considerable amount of the heat we put into the kiln escaping to atmosphere as radiated, convected and conducted heat. Investigation reveals that it is not economic to exceed a certain standard of insulation. Once this standard is reached any further increase in insulation results in such an increase in the interface temperatures that higher quality materials must be used. These higher quality materials are very likely to be more conductive per unit thickness, so that eventually we may end up with an expensive and more bulky construction only very slightly more efficient.

Fig. 3 shows four combinations of refractories and insulations. No. 1 arrangement is a typical arrangement used in many tunnel kilns and giving good results. An attempt to improve insulation by putting in a greater width of powder will result in the state of affairs shown in No. 2, which gives the results of the conductivity calculations. However, such results will not be obtained in practice because due to the interface temperatures exceeding the permissible temperatures for the materials the insulation will break down and probably a very badly insulated structure be obtained as a result of excessive shrinkage of the materials. A better construction is shown in No. 3 arrangement. Here we have good insulation and economy of material and labour in construction. No. 4 represents an attempt to better No. 3 arrangement. The gain in insulation is very slight and does not justify the increased risks incurred in raising the interface temperatures and the expense of extra insulating material.

(b) Heat Transfer

The ideal is, of course, to build a tunnel kiln to heat up and to cool down truck loads of ware at the same time/temperature cycle as can be obtained with single pieces. Passage kilns, by virtue of the fact that the mass of the fired pieces and the supports is very small compared to the large mass of the tunnel kiln load, obtain a very much better firing efficiency than tunnel kilns. Such small masses permit rapid transfer of heat and of course the difficulty of obtaining uniformity of temperature is correspondingly minimised.

The diagram (Fig. 4) shows this very clearly. Experience (as distinct from

mathematics) tends to show that cross-section B having four times the cross-section of A would require twice the heating time to give the same degree of heat penetration. The major source of heating is in both cases on the outer periphery. In case B, it becomes extremely difficult to force sufficient heat into the passages to give the same intensity of heating as we obtain without difficulty on all the faces of A. Also there is an upward movement of heat due to convection which is not very important in A but very serious in B due to the increased height of the composite mass and the vertical passages through this mass.

Our practical kiln therefore requires a longer heating time than our ideal kiln, and furthermore, there is a loss of heat due to convective movements.

(d) Leakages

Leakage of any type, at any point in the kiln (even the cooling zone) inevitably entails expenditure either in the form of extra fuel or in power expended in actuating temperature equalisation devices. Sometimes the effects are negligible, very often they produce faults difficult to cure. It is instructive to consider the effect of leakage into the cooling, peak temperature, and preheating zone separately.

Cooling Zone Leakage

The most common leakage is from under the cars into the tunnel via sandseal and between the frames of the cars. The cool air thus entering causes a drop in temperature of the lower part of the outside surface of the setting.

This is generally not serious for such ware as earthenware, tableware, tiles, bone china, in the biscuit or glost state. For heavy clay kilns the inleakage might even be advantageous, but not so for such delicate products as silica bricks and roofing tiles, also abrasive wheels, which are usually fired in kilns with very long cooling zones amounting to 50 per cent. or even 60 per cent. of the full length of the kiln. In kilns with such very long cooling zones the cooling takes place to a large extent by natural convection and radiation and the amount of air movement towards the combustion zone has to be strictly limited and kept under close control.

Extra fuel is required to make up for the drop in temperature of the air moving towards the combustion zone but observation has shown that this extra fuel must be relatively small in the orthodox type of kiln for tableware or similar products.

Combustion Zone Leakage

Leakage via the sandseal has a direct

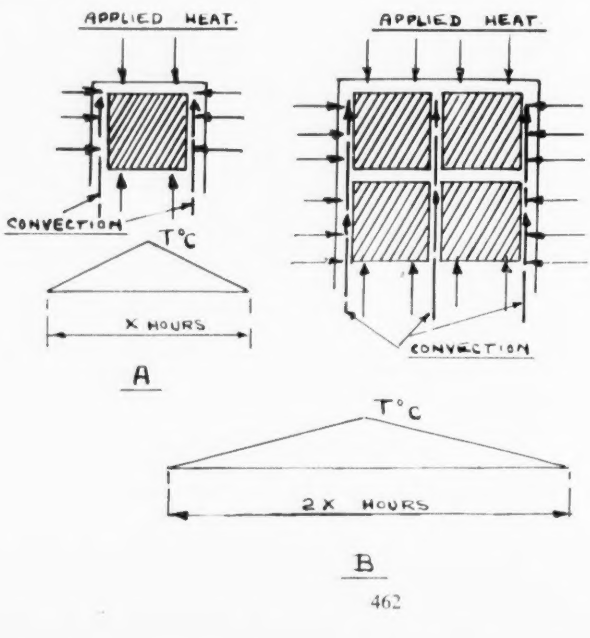


Fig. 4

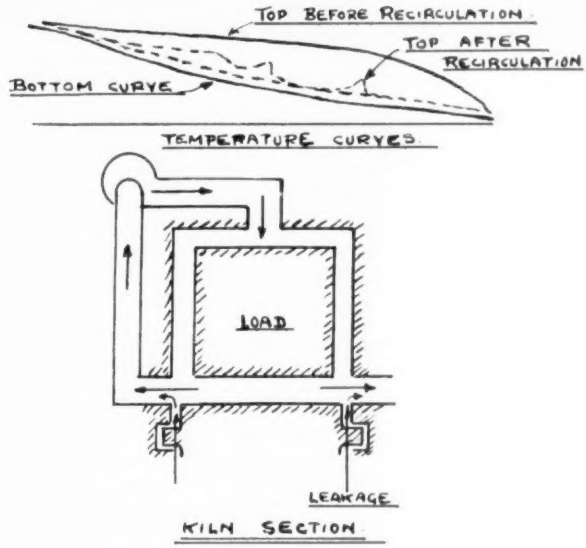


Fig. 5

effect on the bottom temperatures. Even worse is the effect of leakage between the cars. The sandseal leakage can be effectively compensated by extra fuel without any great difficulty because this leakage takes place in the zone first attacked by the burners. Leakage between cars, however, attacks the most vulnerable part of the load, and also this happens to be the most difficult part of the load to bring up to temperature. Attempts to cure the centre may lead to overheating of the sides.

The importance of an efficient and well-maintained sandseal and seal between cars cannot be too strongly emphasized. On one kiln firing biscuit tableware in saggars, attention to the sandseal improved the fuel consumption by some 10 per cent.

Preheat Zone Leakage

Normally the preheat zone works under great difficulties. There is a powerful convection movement upwards, also a drift along the top of the setting, and in addition reverse currents of cool gases moving from the direction of the entrance into the lower parts of the setting. There also exists in most kilns a negative pressure which can attain quite substantial proportions. Sandseal and inter-car leakage added to the undesirable effects already attacking the heat distribution in the preheat zone can therefore produce a state of affairs most difficult to correct.

The direct method is to add heat in the form of products of combustion into the bottom of the ware. This can lead to the expenditure of quite a substantial amount of fuel, with not always satisfactory results because convection and drift tend to be increased by the admission of more gases into the lower parts of the load so that the preheat zone may eventually be working with a dangerous amount of heat in the top of the load with consequent trouble due to too rapid heating up of the load.

Application of recirculators, either of the medium pressure jet type or of the volume type with controvee nozzles can do much to correct heat distribution, but it must be pointed out that recirculators are prone to produce a general reduction in temperature of the load which must be balanced by some use of the preheating burners. Ideal recirculators would suppress part of the top heat and supply an exactly corresponding amount of heat to the bottom.

In practice the loss of heat takes place because the recirculating gases have cool or even cold air mixed with them. Fig. 5 shows what happens to the top curve as a result of cold air admixture.

VELOCITY OF CONVECTION CURRENTS RESULTING FROM VARIOUS TEMPERATURE DIFFERENTIALS ACTING FOR VARIOUS HEIGHTS.

TEMP DIFFERENCE °FAH	VELOCITY — FT/SEC	
	HEIGHT 1FT	HEIGHT 4FT
1	·362	·724
10	1·145	2·290
50	2:561	5·122
100	3·622	7·244
200	5·123	10·246
300	6·275	12·550
400	7·245	14·490
500	8·100	16·200
600	8·873	17·746

Fig. 6

It is not always realised how powerful is the convective effect on a burner system operating in a tunnel kiln. Fig. 6, which shows the velocity of convective currents resulting from various temperature differentials acting for various heights, shows how powerful is the tendency for combustion gases to rise and the consequent difficulty in obtaining bottom heat in a tunnel, particularly in a preheating zone where preheating burners are fitted. For this reason low velocity burners in preheating zones are liable to fail to achieve their object.

From consideration of the effects of leakage into cooling, main, and preheating zones we can say quite definitely that the only type of burner which fulfils the requirements is a high velocity burner, with little or no primary aeration, directed across and under the bottom of the load, and set at other points in the tunnel wherever heat is required to make up a deficiency. This type of burner is also the only type capable of efficiently making use of the hot air current from the cooling zone as combustion air. Aerated burners whether high or low pressure makes use of this hot air as excess secondary air with a consequently higher fuel consumption.

(e) Cooling Difficulties

In the ideal kiln, no difficulties exist in extracting from the ware in the cooling zone all the sensible heat contained by the ware. In a practical kiln, however, there is always some difference between the temperature of the cooling air and the ware at all points of the cooling zone.

For a very open setting, this difference may be slight, for saggar placing and heavy clay lading it may be very considerable. The cooling air tends to flow generally along the sides and top, the result being fastest cooling of the ware at the sides and top and a much slower release of heat in the centre of the load.

Since the bulk of ceramic ware must be cooled with due regard to cooling gradients, the rate at which the sides can be safely cooled sets the pace for the entire cooling cycle and determines the length of the cooling zone. Even with a long cooling zone so that the best conditions of heat transfer are obtained, the hot air flowing among the cooling goods may have as much as 600° to 700° C. lag compared with the average temperature of the ware at peak temperature.

Radiation losses from the structure of the cooling zone and the effect of cavity wall cooling all tend to reduce the temperature of the air flowing into the combustion zone. It can truly be said that this temperature lag constitutes one of the greatest obstacles to the building of a really efficient kiln.

Recirculating cooling systems properly applied, so that more heat is extracted from the ware than is lost to atmosphere by radiation from the recirculating elements, can be of assistance in boosting up the final temperature of the air into the combustion zone.

On kilns where heat transfer is rapid due to very open setting and thin ware, all the cooling air can pass to the main zone and reaches this with comparatively little temperature lag. On kilns with very closed settings and thick ware, it is essential to tap off part of the cooling air before it reaches the main zone. The reason for this is that the volume of air required to cool down the ware is far too high to serve as combustion and excess air in the tunnel, also it would reach the main zone at too low a temperature for this purpose. We see thus that for combustion efficiency we are forced to tap off hot air from the cooling zone in some places, but the amount must be strictly limited.

The conclusion from the above is that the peak temperature burners have to make up the deficiency of temperature in the air passing into the combustion zone. An aerated burner will do this wastefully. A non-aerated burner will be economical by using the air as combustion air.

(f) Momentum Effects

These occur on all tunnel kilns and are most difficult to deal with. They arise from the fact that gas streams even at low velocities have appreciable momentum and consequently tend to follow a straight path. Fig. 7 shows what happens near the exhaust ports and will no doubt be of interest to those who have wondered at the lack of response encountered when adjusting exhaust port dampers on tunnel kilns.

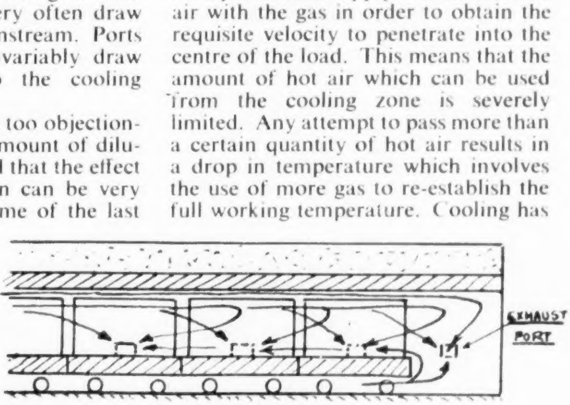
(g) Reverse Movement of Gases

The orthodox system of relief ports fitted to the cooling zones of tunnel kilns must be treated with great discretion. Relief ports very often draw both upstream and downstream. Ports near the main zone invariably draw combustion gases into the cooling system.

While this may not be too objectionable if there is a large amount of dilution, it should be realised that the effect on the fuel consumption can be very considerable because some of the last part of the cooling zone becomes in effect an extension of the heating zone with some of the gases moving in the reverse direction into the cooling zone and consequently all the heating effect of these gases is lost to the preheating zone. It can be argued with a certain amount of justice that all the heat generated is recovered in the form of hot air. To this it can be replied that very often the adjustments are made for the purpose of cooling curve control with no thought of recuperating hot air, consequently the excess of hot air may be quite valueless, particularly when obtained with the dangerous effect shown on Fig. 7.

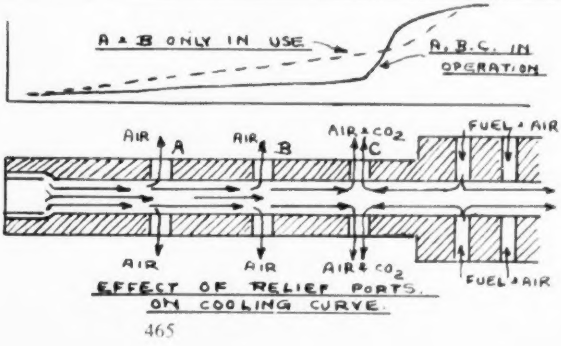
(h) Combustion System Design

The designer can adopt one of two courses. He can generate heat in large combustion boxes, either fully open to the tunnel or with restricted openings to spread the heat into the bottom of the load. With such a design he is practically forced to supply full combustion air with the gas in order to obtain the requisite velocity to penetrate into the centre of the load. This means that the amount of hot air which can be used from the cooling zone is severely limited. Any attempt to pass more than a certain quantity of hot air results in a drop in temperature which involves the use of more gas to re-establish the full working temperature. Cooling has



EFFECT OF MOMENTUM ON FLOW.

Fig. 7



EFFECT OF RELIEF PORTS ON COOLING CURVE.

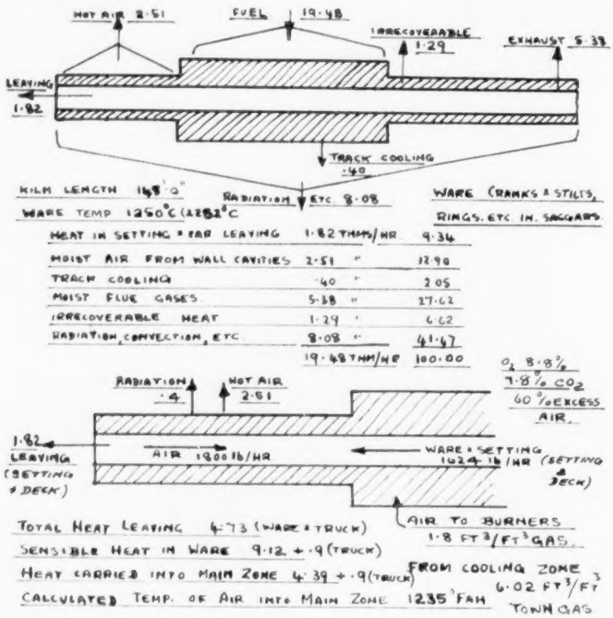


Fig. 8

to be accomplished by the use of relief ports and cavity wall cooling and the kiln is constructionally incapable of reaching more than a certain degree of combustion efficiency.

The second alternative is to burn the fuel in the tunnel using only some or no air whatsoever admitted with the gas. The combustion air is then that already passing into the combustion zone from the cooling zone. This system requires the provision of a large number of small high-velocity gas jets which produce very rapid flame propagation and a very clean atmosphere, together with excellent heat distribution, all obtained quite automatically.

It will be appreciated that since no air is put in with the fuel the efficiency is the maximum obtainable. Furthermore, the elimination of large combustion chambers allows a very much higher degree of insulation to be reached in the burner section. Naturally little heat is available in the form of hot air from the cooling zone.

This system has been applied to a variety of kilns for a large range of products, one outstanding example being a producer gas fired kiln firing silica bricks taken up for a long period to 1,500°C. Also a large tunnel kiln for refractories fired by natural gas working regularly at 1,475°C. Other kilns for tableware, biscuit, bone china, electroporcelain, kiln furniture, floor and wall tiles give very efficient results.

Conclusions

From considerations derived from the ideal kiln and modified in accordance with limitations found in practice we can now summarise our conclusions: —

(1) Kilns following the combustion principles of the ideal kiln are entirely practical and give excellent results in fuel economy, control of atmosphere, and heat distribution, firing medium density loads on fast cycles or very dense loads on slow cycles.

(2) Such kilns in general give no hot air from the cooling zone so that firing efficiency is at a maximum.

(3) Withdrawal of hot air from kilns working with dense loads on relatively fast cycles is necessary and desirable for both overall and combustion efficiency.

(4) The lower the CO_2 content in the

peak combustion zone, provided it is not due to leakage or excess air to the burner system, the higher the combustion efficiency.

(5) Measurement of the CO_2 content of exhaust gases and comparison with the CO_2 content obtainable by theoretical combustion is no indication of combustion efficiency and in fact can be most misleading.

Finally, two actual heat balances may be of interest.

Fig. 8

This gives the data obtained on a tunnel kiln 148 ft. 0 in. long firing kiln furniture (i.e. cranks, thimbles, supports, etc.) in saggars, erected in 1950 in Stoke-on-Trent. Fuel is town gas through high pressure burners with little or no air, temperature being 1,250° C. No heat is withdrawn directly from the cooling zone tunnel, but as will be seen 2·51 therms per hour is withdrawn from the cavity walls of the cooling zone. By subtraction of the total heat lost and extracted from the cooling zone from the sensible heat in ware and part of truck deck moving into the cooling zone, we obtain a balance of 5·29 therms per hour moving into the burner zone. From this heat quantity and the weight of air moving, viz. 1,800 lb. per hour, we calculate an approximate air temperature of 1,235° Fahr., which is well in excess of the temperature of air obtainable from cavity walls or metal recuperating pipes. Also, the volume of this very hot air works out at 6·02 cubic feet at N.T.P. per cubic foot of gas consumed for the entire kiln, from which it is obvious that there must be a very oxidising atmosphere in the burner zone local to the cooling zone, because obviously only a small proportion of the gas is fed into this zone. Also, a substantial gas economy must result from (a) the high air temperature, and (b) the substantial volume of this hot air in relation to the gas admitted at peak temperature. Unfortunately, no gas analysis was taken at peak temperature, the only gas analysis being taken well out of the main burner zone at

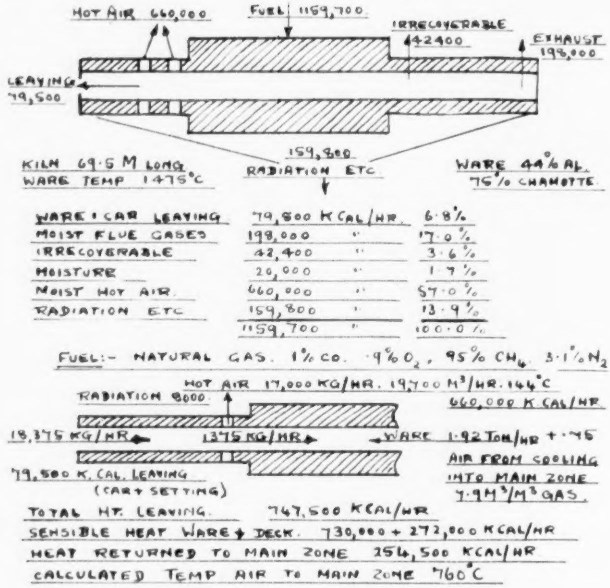


Fig. 9

which point 7·8 per cent. CO_2 equivalent to 60 per cent. excess air was obtained. This confirms that a high excess air percentage must exist in the peak burner zone, although the 7·8 per cent. CO_2 figure might of course be produced by some leakage air.

Another interesting figure is the relation of the weight of air from cooling zone into main zone to the weight of setting and deck. The deck figure adopted is a purely arbitrary one. Nevertheless, there is a fair agreement between 1,800 pounds of air and 1,624 pounds of setting and deck which would indicate that heat interchange is reasonably satisfactory and efficiency of the cooling zone relatively good.

Fig. 9

We now pass to a kiln which yields for factory use a very large quantity of hot air from the cooling zone, as distinct from the previous example which yields no hot air whatever directly from the tunnel.

The kiln is a large kiln 69·5 metres long producing some 322 tons per week of high quality refractory squares and specials at a temperature of 1,475° C.

This kiln, erected near Venice in 1952, is fired with natural gas and is fitted with high pressure burners working with only a small amount of primary air for nozzle cooling purposes and prevention of carboning in the nozzles. As can be seen from the data, the performance is exceptionally good, in spite of the high amount of hot air recuperated. No less than 57 per cent. of the heat input is recuperated from the cooling zone which allows the complete drying of the refractories from 16-18 per cent. to 1 per cent., no mean performance! Calculated temperature of the hot air into burner zone works out at 760° C., the rather low temperature being explained by the fact that a very great deal of air is blown into the cooling zone and then exhausted so that the residual air reaching the main zone is necessarily at a low temperature in comparison with the firing temperature of 1,475° C. Nevertheless, this 760° C. is higher than could be attained with cavity walls or metal tubing. Also 7·9 cubic metres of air at N.T.P. flow from cooling zone into main zone for every cubic metre of gas burnt in the entire kiln, so that the atmosphere in the peak zone must be extremely oxidising. Relation of weight of air into main zone with the weight of refractory and deck moving into cooling zone is not too good at 1,375 to 2,670, but this is only to

be expected in view of the large measure of recuperated air.

The burner system is interesting because it consists of a large number of tiny gas jets of high pressure gas at three levels projected straight into the refractory setting, with little or no air. These jets are positioned a few inches only from the face of the setting. Nevertheless, no trouble is experienced due to heat concentration and heat distribution is excellent in all parts of the setting.

NEW BRITISH STANDARDS HEADQUARTERS

THE British Standards Institution recently held an "At Home" to members and the Press at which we had an opportunity of inspecting the new headquarters of the Institution.

The move of B.S.I.'s many scattered departments from what had been described in a Government Report as the "rabbit warren" of offices in Victoria Street and Gillingham Street took place at the beginning of August, and in spite of the complexity of the job, it involved remarkably little interruption in B.S.I.'s normal services to members. After some two months in occupation the great advantages of the central and well-planned eight-floor building are becoming more apparent.

From members' point of view the new premises offer greater convenience—in the form of more and better committee rooms, and easier access to B.S.I. personnel and to such key sections as the Sales Branch and the Library.

The full effect of all these advantages is seen in better and speedier service to those thousands of people in industry and commerce who are the core of B.S.I.'s membership and the actual producers of its most effective work. Considering how much has been gained on all sides by the move, it seems almost incredible that the floor space now occupied is but little greater than it was in the old premises.

Not the least interesting part of the move is the way in which a building designed for luxury residential purposes has been adapted for use as a strictly utilitarian and efficient office unit. The extensive conversion necessary was carried out by the owners of the building exactly to B.S.I.'s requirements and under the supervision of the Institution's own architect, Mr. Rowland Pierce.

The Story of the Danish Porcelain Industry

by M. GORDON

IT is exactly a hundred years since the porcelain factory of Bing and Grøndahl was founded, and this has significance for many people who live far beyond Denmark's limited frontiers. For the name of Bing and Grøndahl stars some of the most cherished porcelain figures in Europe and America, to say nothing of dinner services and tea services that grace royal tables.

It seems that the love of art has been a ruling passion in the Bing family for several generations. H. J. Bing made his entry into business as long ago as 1820, and soon he was specialising in the sale of fine and applied art. His shop, which was the first to have low windows, displayed engravings, and models which represented the arts and crafts of many countries. Guided by H. J. Bing's good taste and excellent judgment the business prospered and had attained a fair size by the middle of the nineteenth century.

"Young Tiger," sculptured by Jean Réné Gauguin and executed in roche céramide.
(Courtesy: Danish Foreign Office Journal)

Frederik Vilhelm Grøndahl, the other original partner in this world famous business, was at that time working at the Royal Porcelain Factory. He was a young man with far-ranging ideas, and he suggested that the Royal Factory should enter into the production of figures and reliefs in the unglazed porcelain that is popularly known as "biscuit."

He visualised the production of genuinely artistic creations, and he was anxious that the designs used should be those of the Danish sculptor Thorvaldsen. But the Royal Porcelain Factory saw no reason to develop this type of production. The market was absorbing a satisfactory amount of their china ware and all their established lines, and they saw no advantage in developing a medium which would prove costly and might well fail.

Their rejection of Grøndahl's suggestions was destined to provide them with a serious competitor, for the young man was determined to see porcelain art given its chance in Denmark. To this end, he persuaded the brothers M. H. and J. H. Bing to subscribe money to the founding of a porcelain factory.

Grøndahl intended the factory to devote its production exclusively to artistic works, but the Bing brothers insisted on a much broader basis. Thus, when the factory was opened in 1853, it went immediately into the

Tureen in over-glazed ware with gold ornamentation; part of a service made for King Christian and Queen Alexandria of Denmark

(Courtesy: Danish Foreign Office Journal)

production of porcelain in all its forms. Unhappily, Frederik Grøndahl was not destined to live to see the factory thoroughly established, for he died only three years after the firm came into existence.

With its wide basis of the production of all types of porcelain, Bing and Grøndahl's prospered, and it has struck a balance between the conflicting claims of utility and art, in many cases by uniting the two qualities in the same product. The distinction between these two qualities is not determined by the nature of the article. For instance, a dinner service designed for the Danish royal household, although made to be used as a dinner service, is so beautifully designed and constructed that it is a genuine work of art.

On the other hand, the firm has sometimes been compelled to recognise that figures intended purely as works of art have lacked the qualities of beauty and design that would have raised them to the necessary artistic level, and these have had to be rejected. This is by no means true of all their purely artistic creations, of course, and Bing and Grøndahl's group "The Seal," sculptured by Kai Neilson, is an example of the beauty in glazed porcelain that has few superiors in that particular medium.

When the Royal Porcelain Factory found that it faced the competition of Bing and Grøndahl's, its directors had no choice but to take steps to preserve itself by competing in the same lines. Thus, although he was never to learn the fact, Grøndahl was responsible for the Royal Factory venturing into the field of artistic productions, and doing so with considerable success.

Today, both concerns compete with each other for both the home and export markets, and each firm has acted for years as a stimulant to the other. Neither has been able to relax its efforts to gain and hold the markets which absorb their products, and the result has been beneficial to both companies and to Denmark as a whole. For it is recognised by both organisations that Denmark would never have had a porcelain industry of noteworthy importance had there been no competition in that field.

In the sphere of under-glaze ware, Bing and Grøndahl have made an invaluable contribution by introducing

new colours. When Europe took over this type of production from the Chinese, blue was the only colour for under-glaze ware. Now customers have a choice of several colours, a fact which is appreciated in many countries in Europe as well as in America. In fact, the under-glaze ware produced by both Bing and Grøndahl's and the Royal Porcelain Factory is in great demand all over the world.

In the whole field of production the two firms compete relentlessly, and this means that the pottery artists in each firm act with the knowledge that their products must be the best that art and skill can devise. This is true even of stoneware, for both firms produce some excellent items in this medium.

Strangely, therefore, there is a touch of irony in the history of Denmark's ceramics industry. For in suggesting to the Bing brothers that a factory should be established to produce porcelain objects of art, Grøndahl brought into existence a concern that was to prove a lasting rival for the Royal Porcelain Factory. Yet Grøndahl himself hardly had any significant place in the new company that he inspired, and his own ideas as to the nature of its products were not accepted as he had wished or intended. Nevertheless, had it not been for Frederik Grøndahl porcelain production in Denmark would never have achieved its world-famed importance and eminence.

Fuel Efficiency Exhibition —Manchester

NORTH-WESTERN GAS BOARD.

AN exhibition of potting on this stand by a team of student art potters from the Regional College of Arts, Manchester, was a focus of spectator interest.

Vases, bowls, jugs, etc., were being thrown from red earthenware and stoneware clays supplied by Potclays Ltd. After drying the ware was fired both biscuit and glost in a gas-fired kiln of the semi-muffle type built to the design of the North Thames Gas Board. The kiln was equipped with an Ether indicating pyrometer.

The students, who had both coiled and thrown pots on show, intended eventually to make a living as individual potters.

WEST'S GAS IMPROVEMENT CO. LTD.,

Miles Platting, Manchester 10.

On this stand was an interesting working model of West's Selective Screen Conveyor—a development which offers a new approach to the grading problem. The Screening Conveyor combines distribution with screening by progressive elimination without causing vibration in the supporting structure, the system being unique in that the material to be graded is carried on a non-vibrating surface throughout the screening process. So far, the Selective Screen Conveyor has been applied mainly to the grading of coke, but there is no doubt that the principles it embodies have a wide application in the handling and grading of other materials, including coal.

The screen is basically a normal flat band conveyor with the addition of comb-like screening units mounted above the band at an angle across the line of travel. To prevent clogging, these units are fitted on flexible rubber and steel mountings and provided with electric vibrators which impart oscillations of high frequency and low amplitude to the units at a low power rating.

The conveyor grades in descending order of size and this fact, coupled with the non-vibrating nature of the carrying surface, means that little damage is done to the material, as may happen where the largest size passes through a number of oscillating devices before being finally separated. Capacity depends upon width of band and the conveyor is constructed on unit principles so that its length can be readily altered in accordance with any handling scheme. The screening elements can also be varied in gauge to suit requirements. The advantages of the Selective Screen Conveyor may be summarised as follows:

Correct order of grading; high efficiency, even when considerably overloaded; screening of coke and breeze or similar materials of high moisture content without blockage of screening elements.

PRIOR STOKERS LTD.,

1/3 Brandon Road, London, N.7.

Exhibits included Prior Bunker Flow and Hopper Type Underfeed Stokers which are suitable for application to various types of Boilers, Furnaces and Kilns and thereby giving rise to greater efficiency and considerable saving in costs.

Prior Stokers Ltd. also manufacture a brick-mounted portable stoker for kilns and similar applications where it is required to fire in rotation. This greatly reduces the capital outlay required.

RILEY STOKER CO. LTD.,

19 Woburn Place, London, W.C.1.

The trickle-feed Kiln Stoker exhibited automatically releases a small stream into the kiln below. Most of this coal, it is said, ignites as soon as it enters the chamber and the rest is fully consumed on the kiln floor. The stoker may be adapted to most types of continuous brick kiln.

THE MORGAN CRUCIBLE CO. LTD.,

Battersea Church Road, London, S.W.11.

In keeping with the theme of the Exhibition, The Morgan Crucible Co. Ltd. stand featured two of the range of Morgan Low Heat Storage Insulating Refractories. They are M.I.28, for use at 2,800° F. (1,538° C.) and M.I.23, 2,300° F. (1,260° C.). These refractories are light-weight hot-face insulating refractories which have been specially developed as a contribution to the national need for increased productivity and reduced production costs.

The use of a hot-face lining in furnaces substantially reduces heat losses both by a reduction in the heat actually stored in the brickwork and by a lower conduction of heat through the material. This is especially valuable in intermittent furnaces when valuable time is taken in reaching working temperatures.

The typical characteristics of these bricks are:

		M.I.28.	*M.I.23.*
Bulk density		47·5 lb./ft.^{3}	36 lb.ft.^{3}
Thermal conductivity	1,000° F. (538° C.)	2·9	1·3 1·7/B.Th.U./hour in. ft.^{2} ° F.
	500° F. (260° C.)	2·4	1·3 1·7/B.Th.U./hour in. ft.^{2} ° F.
Cold crushing strength		100 lb./in.^{2}	80 lb./in.^{2}

Other products from the wide range of refractories manufactured by the company which were shown are M.R.I. and M.R.60 Super Duty Firebricks—a range of "Can and Bag" refractories including M.I.22 Insulating Concrete (2,200° F./1,200° C.) "Triangle" Refractory Concrete No. 849 (1,350° C.), M.R. Plastic Mouldable (1,650° C.) and M.R. High Temperature Castable (1,600° C.)—"Triangle" Pure Oxide Ware for process and research work—"Triangle" Refractory Tubes for pyrometry, combustion analysis, insulation, heat treatment and recuperation, and a selection of crucibles, muffles and other shapes from the range of "Battersea" refractory ware.

Institution of Gas Engineers

44th Report of the Joint Refractories Committee

THE following is a summary of this report, which was presented to the Institution of Gas Engineers, Nineteenth Annual Autumn Research Meeting, held in London on the 24th and 25th November, 1953:

The new Joint Refractories Committee has decided that the number of research items to be selected for detailed consideration in its annual report to the gas industry might with advantage be increased. In previous years it has been the custom to select only two or three research items for detailed consideration, but this year the number has been increased to four. This does not, however, cover all the current investigations; those that have not yet reached the necessary degree of advancement to warrant a detailed report are included in a "Progress Report of Other Investigations."

All the investigations have been carried out on behalf of the industry by the staff of the British Ceramic Research Association, under its director, Dr. A. T. Green, O.B.E.

The first investigation to be described is concerned with a peculiar growth that occurred during the working life of a battery of intermittent vertical retorts. When these retorts were dismantled it was found that the growth could be explained by the deposition of carbon in the joints of the top fireclay section. Tentative suggestions have been outlined regarding the mechanism by which this deposition took place. Although carbon has penetrated the brick texture, it appears certain that the deposition was mechanical rather than chemical and was in no way similar to the well-known deposition of carbon around iron spots that is a feature of firebrick linings in blast-furnace stacks.

The second item in the report is a description of the latest results of the investigation of the clay-quartz system, which is in progress in the laboratories of the University of Leeds, under the supervision of Prof. A. L. Roberts. This paper gives a further insight into the mechanisms that govern the conversion of quartz in silica and siliceous refractories. Pure quartz itself will transform at high temperatures, the reaction commencing at surface defects and then propagating into the interior of each grain.

The addition of solid catalysts or mineralisers provokes intense activity in the immediate vicinity of each particle of catalyst, so that the greatest acceleration of the quartz conversion, for a given amount of catalyst, will result if the catalyst is finely divided or added as a solution. With small additions of catalyst the conversion proceeds in the initial stages mainly by catalic action, but this eventually gives way to the conversion mechanism of pure quartz.

Of the catalytic agents that act entirely in the solid state, calcium oxide is more vigorous than either magnesia or titania. Alumina, on the other hand, has a pronounced retarding influence on the rate of conversion and also on the catalytic activity of other substances.

When the added substance is capable of forming liquid at the temperature of firing, as is the case with iron and the alkali oxides, the conversion proceeds rapidly to completion. The liquid phase in spreading throughout the mass brings the catalyst into contact with many more quartz particles.

Thermal conductivity data have been continuously compiled by the British Ceramic Research Association since its inception, and the work is again reported

on in the third paper of this report. During these thirty years, the object of the work has been to obtain accuracy at higher temperatures, since the liability to error increases very rapidly as the mean test temperature is raised. Some years ago the standard panel test was modified, the maximum temperature of the hot face of the specimen being increased from 1,200-1,400° C. The cold-face temperature was also raised by interposing insulation between this face and the calorimeter. To ensure that straight-line heat flow was maintained through the specimen, lateral heating was introduced. This apparatus has now been used to measure the thermal conductivity of a wide variety of refractory materials with, it is thought, an error not exceeding ±5 pr cent. In order to obtain more information on the reliability of the results, it was decided to compare the data obtained from the Research Association's apparatus with that obtained from an apparatus designed by the American Society for Testing Materials and used in the London laboratory of the Morgan Crucible Co. Ltd. Naturally, the same test panel had to be used in both types of apparatus, and this necessitated measurements being made first at the London laboratory, the panel then being sent to the Research Association and used in its apparatus.

In general, the results from both types of apparatus showed very satisfactory agreement, the maximum discrepancy of 4·5 per cent. occurring in an insulating brick panel. This is good evidence that the conductivity values as measured by both methods are near the true values, the accuracy involving a possible error of less than ±5 per cent.

The fourth paper in the report describes recent investigations on the length changes that take place in insulating bricks when forming part of a furnace wall. Seven brands of bricks were built into the door of a laboratory furnace and heated for periods of up to 6 hours at temperatures between 1,200° C. and 1,400° C. Under these conditions, the hot face usually showed a slight expansion in the 9 in. direction, whereas small blocks uniformly heated inside the furnace showed appreciable contractions. The expansion of the hot face appeared to change slowly to a contraction when the heating period was extended up to 80 hours but at no time did it show the full contraction developed when the specimen was uniformly heated for a similar period. The investigation was next extended to firebricks heated at 1,400° C. for a 2-hour period. Firebricks were found to behave in a similar manner to insulating bricks in that the hot face appeared to grow. On heating firebricks for greatly extended periods of up to 200 hours at temperatures ranging from 1,125-1,330° C., depending on the type of brick, the expansion in the 9-in. direction tended to be reduced while there was a progressive contraction along the 3-in. direction. The investigations are continuing, but up to the present time no general rule has emerged by which the initial contraction temperature can be used to forecast the safe maximum temperature to which a brick can be subjected in service.

Among the research projects listed in the "Progress Report of Other Investigations" are the two temperature surveys. One of these is in process of being recorded, and continuous temperature measurements have been made since April, 1953. The second survey is scheduled to begin with the warming up of the retorts about the middle of September, 1953. Both surveys should be complete in time to be included in the next report of the Refractories Joint Committee. It would appear also from the progress report that the laboratory experiments on flaking do not completely simulate plant conditions since panels of sillimanite material installed in two downwardly-heated retorts appear to be flaking as severely as silica material. When the forty-third report was introduced to the gas industry, in November, 1952, Dr. A. T. Green, O.B.E., made a strong case for a vigorous investigation to be conducted on the nature and properties of gas works' scurf. It would now appear that the shrinkage properties of the scurf are directly related to the flaking of the sillimanite material, and no doubt other evidence is not lacking to emphasise the importance of obtaining a knowledge of the properties of scurf in order to visualise more clearly the mechanism of flaking.

Silica shapes for carbonising installations are sometimes rejected because they are marked with iron spots. There is no conclusive evidence for or against the view that iron spots have a deleterious effect on the durability of the refractories, but some gas undertakings are unwilling to accept what they consider to be a risk of premature failure. An investigation is to be commenced in the near future on the effect of iron spots in silica materials. It is hoped that information will be obtained on which a more firmly based judgment of the matter may be constructed.

Ideal Home Exhibition.—The dates fixed for the 1954 Ideal Home Exhibition at Olympia, London, are from the 2nd to the 27th March.

Filter-Presses for Porcelain and Earthenware Slip

THE filter-press represents an integral unit in the removal of water from porcelain or earthenware slip, besides other corresponding materials in ceramic productions. Controversy existed for some time that vacuum filter drums were better suited for the purpose, but investigations proved that there were limits to their use. With the fatty types of clay, the vacuum produced is insufficient to form the desired dry filter cake, and secondly, it is only material which can be easily filtered which permits this system. Attempts were likewise made to simulate chemical practice in substituting centrifugals, and research on this is still in progress. It has been pointed out that although the evaporator system, wherein surplus water is removed, holds certain advantages, the plasticity of the clay is apt to suffer by the heating applied. Hence, the filter-press still remains unsurpassed for the purpose of removing surplus water, and has recently enjoyed a number of improvements in design, to meet the requirements of the ceramic worker.

Until recently, hydraulic locks used for these presses were an intermediate between a hydraulic piston, and an earlier spindle lock with a swivel piece. The distance between this spindle traverse and the pressure plate was bridged over by applying the swivel piece, and operating a spindle.

This latter was built into the hydraulic piston, and hydraulic pressure was applied only to the last piece of the locking distance. One of the improved filter-press designs covers the whole distance when opening and closing the press by hydraulic pressure and the action is termed fully-hydraulic. Hydraulic closing pressure only remains effective for a few moments, during the locking process, and does not require to be exerted against the piston during the entire pressing process.

The filter plates of the earlier filter-presses were made of oak or pitch pine, which held the advantage that the porcelain or earthenware body was not impaired by rust, to which these materials are very sensitive.

As the durability of the wood was somewhat limited, plates made of cast-iron covered with hot galvanised, perforated screening plates, were substituted. Despite this, the repeatedly applied protective coating was contended to be insufficient to prevent the formation of rust, and efforts have recently been made to find alternative means of ensuring protection against rust.

Improved Forms of Design

When suggestions were first made to line cast-iron plates with rubber, it was found that there could be no guarantee of its durability, apart from it being somewhat expensive, but there were reasons for demanding rubber linings. The individual filter plates must be moved a matter of 1½ feet for the purpose of removing the filter cakes, after a filter-press has been completely pressed out. These plates, however, are not shifted absolutely parallel to each other, as they are hung over their centre of gravity. Where the circular plates with a diameter of some 32 in. are shifted, they will weigh more than 2 cwts. and also it frequently happens that the top of the sealing frame will come in contact with the sealing frame of the plate which precedes it.

Two filter cloths which exist between each filter plate can be very easily impaired by this impact, and it transpires that all cloths are damaged by the striking together of the filter plates, rather than by wearing out naturally. In repairing such cloths, patching must be done along the sealing surface, i.e. just at that point where patching is most undesirable. In order to press the

bulging cloth together sufficiently, the filter-press must accordingly be closed with an exceedingly high pressure, which in turn is liable to lead to the breakage of plates in extreme cases.

It is because of features of this kind that not a few ceramic plants have adhered to filter plates of the earlier wooden variety. Efforts have been made to acquire a form of filter-plate which will be sufficiently elastic that it will not cause the cloths to become impaired even when the plates are struck together, and yet will be rust-proof in operation. On the basis of attaining the desired rubber-lined filter-plate, an improved design is made entirely of hard rubber.

Except that the wide-spaced grooves in the cast-iron plate have been replaced by close-spaced grooves, this rubber plate has the same shape as has the latter.

The operator has to be satisfied with wide-spaced grooves in the case of cast-iron plates, whereas the rubber plate permits much closer spacing. The former grooves are enclosed by perforated sheets, and through these perforations the water reaches the run-off grooves of the filter plates. These sheets are rendered superfluous by the introduction of the close-spaced grooves, whereby it is possible to create a free filter area, which, compared with the cast-iron plate with superimposed sheets, is appreciably larger in size.

Briefly, it is claimed that a filter area is obtained which is 2½ times larger than is possible with plates with steel filter sheets, with a corresponding shortening of the filtering time required.

Much research has been carried out with centrifugals equipped with selected coconut matting, and other special materials, in order to speed-up filtration, as distinct from the filter-press which necessitates the individual filter plates being dismantled and emptied each time. In other researches, use is made of vacuum evaporator principles, in order to remove water below 140° F. without damaging the plasticity of the clay. Both of these systems are at present under scrutiny in order to ascertain how much time-saving could be effected.

J. H. Holtom.—Mr. J. H. Holtom, has been appointed chairman of the North Staffordshire Branch of the Institute of Clay Technology. Mr. Holtom, is hon. secretary of the Potteries Group of the Incorporated Sales Managers' Association.

APPOINTMENTS VACANT

A **VACANCY OCCURS** for an intelligent man with sound knowledge of the industry, and experience of management to take charge of the Biscuit Warehouse and Glazing Department of an up-to-date Tile Works in the Potteries. The salary offered is comparable with that of a Works Manager on a small factory and applicants should be capable of undertaking such duties. Existing staff have already been notified of the vacancy. Apply Box No. 28, CERAMICS, 157 Hagden Lane, Watford, Herts.

TRADESMEN required for all branches of an established Sanitary Fireclay Industry in South Africa. Applicants should write, giving a detailed history of their career, and enclosing references, to Box 3157, Frost-Smith Advg., 64 Finsbury Pavement, London, E.C.2.

WORKS FOREMAN required for an established Sanitary Fireclay Industry in South Africa, with good all-round practical knowledge of making and glazing. Applicants should write, giving a detailed history of their career, and enclosing references to Box 3164, Frost-Smith Advg., 64 Finsbury Pavement, London, E.C.2.

A **SOUTH AFRICAN** firm, engaged in the Sanitary Fireclay Industry, requires the services of a Research Manager, able to initiate and direct the technical development of the company. This post will carry a salary of £1,200 p.a. (or upwards according to experience) and affords opportunity of advancement. Applicants should write, giving a detailed history of their career, and enclosing references, to Box 3171, Frost-Smith Advg., 64 Finsbury Pavement, London, E.C.2.

A **SOUTH AFRICAN FIRM**, engaged in the Sanitary Fireclay Industry, requires the services of a Ceramic Chemist, able to control staff and direct technical development on own initiative. Applicants should write, giving a detailed history of their career, and enclosing references, to Box 3178, Frost-Smith Advg., 64 Finsbury Pavement, London, E.C.2.

THE MORGAN CRUCIBLE CO. LTD., Refractories Division, require a Sales Representative in Scotland for Firebricks and other Refractory products. A Scot with engineering background and some knowledge of boiler or furnace brickwork design would be preferred. Experience of the Metallurgical or Glass or Ceramic Industries an advantage. Write, giving full details and salary required, to the Staff Manager, Morgan Refractories Ltd., Liverpool Road, Neston, Cheshire.

PARTNERSHIP

PARTNER WANTED FOR CERAMIC FACTORY IN CENTRAL AMERICA. Recently completed ceramic and tile factory in Costa Rica, needs partner with technical experience who can supply working capital to start operations immediately. Ample tariff protection and commercial treaties with other Central American countries assures market. Write for information to: CERAMICA INDUSTRIAL COSTARRICENSE LTDA., P.O. Box 2266, San José, Costa Rica, Central America.

FOR SALE

OLD BROKEN STEEL WORKS FIREBRICKS, hand cleaned, regularly for sale. Thomas Mouget and Co. Ltd., 24 Cornfield Road, Middlesbrough.

THE MORGAN FLOAT

Many attempts have been made in the past to try and alleviate one of the principal burdens of the die-casting furnace operator. We refer, of course, to the heat radiation from the molten metal bath; for despite the many improvements that have been made to other items of foundry equipment, inevitably the operator has had to "bale-out" by hand the metal from a furnace, and suffer from the heat given off from the surface of the molten metal. This heat radiation and its effects on workmen has been no small problem, but the Morgan Crucible Co. Ltd. have developed a new segmental insulating cover that should virtually end this difficulty. This is called "The Morgan Float," a product for which patent rights have been applied for.

Morgan Floats are sold in sets of four segments, each segment being made from M.I.22 Insulating Concrete treated with a "Salamander" plumbago coating to act as a protection against wetting by molten aluminium. The four sections float on the surface of the molten metal and, by preventing heat radiation, result in a substantial saving in fuel and a considerable improvement in working conditions.

The presence of the floats does not impede casting in any way. When the ladle is dipped in the metal the segments are easily displaced, but immediately the ladle is removed the segments float back again into position.

One of the Morgan Float segments from a set of four is illustrated here, together with a view of a typical 'bale-out" furnace showing how the sections float on the surface of the metal. In addition to improved working conditions a substantial saving in fuel is achieved

At present Morgan Floats are being made in one size only, this size being suitable for the 200, 300 and 400 lb. aluminium capacity size.

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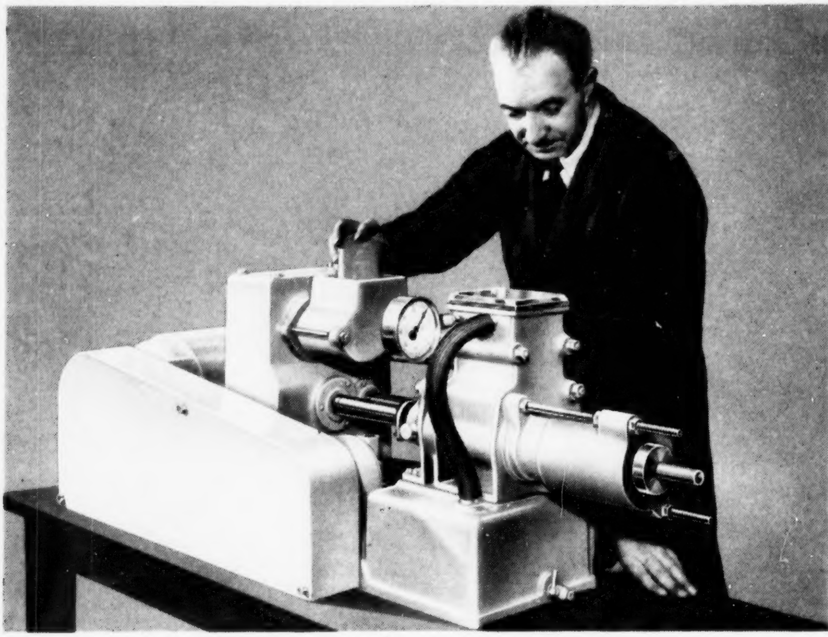

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This new RAWDON 3 inch De-airing Pug—the smallest in our range—is intended primarily as a high-speed production machine where small de-aired extruded sections are required.

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It is a robust two stage machine with totally enclosed gear box with worm drive. It has feed packing rollers in both top and bottom pugs and adjustable mouthpiece. An important feature is the ease with which it can be totally dismantled for cleaning and correctly reassembled afterwards.

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